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# LEVERAGING THE DIGITAL CREDENTIALS OF THE GHANAIAN E-ID TO STREAMLINE HEALTHCARE IN GHANA

Master's Thesis

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# GHANA E-ID DIGITAALSETE ANDMETE KASUTAMINE TERVISHOIUTEENUSTE SUJUVAMAKS PAKKUMISEKS GHANAS

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# Author's Declaration of Originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature, and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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# Abstract

This study explores the perceptions of Ghanaians regarding the use of digital identification cards, specifically the GhanaCard, in accessing healthcare services. A total of 9 participants were recruited through convenience sampling, and data were collected through semi-structured interviews. The findings suggest that participants are generally comfortable with using the GhanaCard to access healthcare services as it provides a means for easy identification and access to medical records. However, concerns were raised regarding the security and protection of personal data and the need for proper data management systems to ensure confidentiality. Participants also highlighted the potential benefits of using digital identification cards to streamline the healthcare system, reduce waiting times and improve overall access to healthcare services. Overall, the study provides valuable insights into the perceptions of Ghanaians towards the use of digital identification cards in healthcare and highlights the need for proper data protection measures to be put in place.

Keywords: GhanaCard, Healthcare, Patient, Confidentiality, NIA, Services, Electronic, Public, Challenges, API, Legal, Silos, Paperless

This thesis is written in English and is 58 pages long, including 8 chapters, 14 figures, and 15 tables.

# Annotatsioon

## Ghana e-ID digitaalsete andmete kasutamine tervishoiuteenuste sujuvamaks pakkumiseks Ghanas

See uuring uurib ghanalaste arusaamu digitaalsete isikutunnistuste, eriti GhanaCardi kasutamisest tervishoiuteenustele juurdepääsul. Mugavusvalimi abil valiti kokku välja 9 osalejat ja andmeid koguti poolstruktureeritud intervjuude abil. Tulemused näitavad, et osalejad on üldiselt rahul GhanaCardi kasutamisega tervishoiuteenustele juurdepääsuks, kuna see võimaldab hõlpsalt enda isikut tuvastada ja juurdepääsu meditsiinilistele dokumentidele. Küll aga tõstatati muret seoses isikuandmete turvalisuse ja kaitsega ning nõuetekohaste andmehaldussüsteemide vajadusega konfidentsiaalsuse tagamiseks. Osalejad tõid välja ka võimalikke eeliseid, mis tulenevad digitaalsete isikutunnistuste kasutamisest tervishoiusüsteemi tõhustamiseks, ooteaegade vähendamiseks ja tervishoiuteenuste üldise kättesaadavuse parandamiseks. Üldiselt annab uuring väärtuslikku teavet ghanalaste arusaamadest digitaalsete isikutunnistuste kasutamise kohta tervishoius ja rõhutab vajadust võtta kasutusele asjakohased andmekaitsemeetmed.

Märksõnad: GhanaCard, tervishoid, patsient, konfidentsiaalsus, NIA, teenused, elektrooniline, avalik, väljakutsed, API, juriidiline, silod, paberivaba

See lõputöö on kirjutatud inglise keeles ja on 58 lehekülge pikk, sisaldab 8 peatükki, 14 joonist ja 15 tabelit.

# List of Abbreviations and Terms

| | |
|---|---|
| BioTAM | Biometric Technology Acceptance Model |
| CDS | Clinical Decision Support |
| EHRs | Electronic Health Records |
| HIPAA | Health Insurance Portability and Accountability Act |
| HL7 | Level Seven International |
| LHIMS | Lightwave Health Information Management System |
| NHIS | National Health Insurance Scheme |
| NIA | National Identification Authority |
| PEOU | Perceived Ease of Use |
| PKI | Public Key Infrastructure |
| PSP | Perceived Security and Privacy |
| PU | Perceived Usefulness |
| SIM | Subscriber Identity Module |
| SSNIT | Social Security and National Insurance Trust |
| TAM | The Technology Acceptance Model |
| WHO | World Health Organization |

# Table of Contents

# List of Figures

# List of Tables

# 1. Introduction and Background

Developing countries face numerous challenges in providing adequate and accessible healthcare services to their populations. In Ghana, for example, healthcare challenges include inadequate funding and resources, limited healthcare infrastructure, and a shortage of healthcare professionals. These challenges often result in poor health outcomes, limited access to healthcare services, and higher mortality rates. To address these challenges, there is a growing interest in implementing technology-based solutions such as electronic health records (EHRs) and biometric identification systems [1].

EHRs have the potential to revolutionize healthcare delivery by improving the quality of care, reducing costs, and increasing access to healthcare services. EHRs allow healthcare providers to access a patient's medical history, treatment plans, and test results in real-time, enabling them to make more informed treatment decisions [1]. Patient access to their own EHRs can also decrease healthcare provision costs, and improve access to healthcare data, self-care, quality of care, and health and patient-centered outcomes [2].

Biometric identification systems, such as fingerprint or facial recognition, can improve patient identification, reduce fraud, and improve the accuracy and efficiency of healthcare service delivery. These systems can help to eliminate duplicate medical records, prevent medical identity theft, and reduce the risk of medical errors caused by mistaken identity [3].

The GhanaCard is a biometric identification card that contains the holder's demographic and biometric data, including fingerprints and facial recognition data. The GhanaCard has the potential to address some of the healthcare challenges in Ghana by providing a secure and portable form of identification that can be used to streamline healthcare delivery. For example, the GhanaCard can be used to facilitate patient identification, improve interoperability of EHRs, and provide patients with easy and secure access to their healthcare records from any healthcare facility within Ghana. The GhanaCard has the potential to improve healthcare delivery in Ghana, but its successful implementation will require careful consideration of the challenges and limitations associated with its implementation. These include infrastructure and resource constraints, privacy and security concerns, and a lack of public trust.

Ghana's healthcare system aims to provide basic and specialized clinical services to a

population of over 30 million, and the Ministry of Health oversees healthcare organizations with public funding [4]. One of the initiatives implemented is the National Health Insurance Scheme (NHIS), which is designed to provide financial risk protection against the cost of basic healthcare for all residents of Ghana. The scheme has contributed to increased access to healthcare services in the country [4]. Additionally, the GhanaCard is a national identity card that includes biometric data, such as fingerprints and iris scans, issued by the National Identification Authority (NIA) to improve access to government services, including healthcare services [4]. While the GhanaCard's use in healthcare services is not explicitly stated in the provided reference, it is possible that the biometric data stored on the card can be used to authenticate the user's identity when accessing healthcare services, thus reducing fraud and improving the accuracy of healthcare diagnoses.

Healthcare in Ghana is a multifaceted and complex issue, with several challenges and opportunities for further development. The country has seen progress in improving access to healthcare, with an increase in the number of doctors and nurses per population, an increase in coverage by health facilities, and a promotion of community-based primary healthcare [5]. The public sector (primary healthcare provider), managed by the Ghana Health Service, provides basic health services free of charge for all citizens, as well as some specialized services for a fee, while the private sector provides additional services for a fee, including specialized care, cosmetic surgery, fertility treatments, mental health services, addiction treatment, orthopedic care, physical therapy, radiology services, cardiac care, oncology services, alternative medicine, eye care, hearing services, dermatology services, and neurology services [4]. The informal sector, composed of traditional healers and herbalists, provides healthcare services in rural areas, but the quality of care is often poor [4].

## 1.1 Relevance and Purpose of the Study

Governments in some developing economies have implemented advanced information and communication technology in the healthcare sector, which is in line with the World Health Organization's (WHO) goal of revolutionizing healthcare. The 1948 Constitution of the World Health Organization states that "the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition" [6], with this said, everyone has the right to access their medical records whenever and wherever. Technology has been a major contributor to improving healthcare in developing economies by reducing the use of paper-based systems in siloed healthcare facilities of which Ghana is no exception. Although Grimson explored the potential of electronic healthcare records in the 21st century [7], while Wickramasinghe has also proposed a framework for assessing e-health preparedness

[8, 9], the majority of developing countries have not made use of this knowledge.

Biometric identification can be grouped into two categories namely physiological (face, fingerprints, iris, etc) and behavioral (voice, gait, etc) [10, 11]. Human life is a valuable ”asset” that is cherished by all and sundry; with that said, biometrics is a crucial aspect of healthcare that has the potential to save and protect human life at the most vulnerable times or circumstances [12]. This is so because during an emergency or when the patient is unconscious or in an operating theatre, with no means of giving out their personal identification number on their physical card, digital (including biometric) data becomes the means of being able to save the patient.

Over the years, Ghanaians and residents in Ghana have not had the privilege of going to any closest health facility (public or private) or any equally good health facility because of the siloed nature of these health institutions. By way of experience, in all healthcare centers (private or public) in Ghana, the researcher has attended for care, has had different parts of the medical history, and also been made to go through a new registration process to acquire a new identification card to be able to access the facility. For cases of medical referrals to another public or private health facility, the researcher had to carry on a printed copy of the information to the other center. Patients do not have a digital copy of their medical records either from a general practitioner of a health facility or a pharmacy readily accessible in any form by the patient; identification is important for the efficient and successful provision of healthcare services [6]. Identification in this sense should not only serve a single purpose but rather be interoperable and responsive to all services.

The purpose of this master's thesis is present how viable the GhanaCard can be used to bridge or leverage the accessibility of healthcare facilities in silos [13], interoperability challenges of electronic health records [14], and inaccessibility of healthcare records by patients from both the private and public sectors with the current setup of the National Identification Authority's backbone which is the public key infrastructure (PKI) for Ghana thereby reducing the burden of manual data entry and eliminating the need for multiple identification cards from different healthcare facilities.

## 1.2 Research Questions

This master thesis focuses on two main aspects - the use of digital (including biometric) data in favor of the citizens of Ghana and the citizen´s perception of the proposed solution. Therefore, the first research question is: *how can the digital (including biometric) data of the GhanaCard be used in favor of the Ghanaian healthcare sector?* This question is chosen to be the pivot on which this master's thesis would evolve. According to the

National Identification Authority, over 16 million, as well as residents in Ghana, have the GhanaCard [15]. However, with the siloed nature of the health facilities [16], the GhanaCard is not being used (redundant), although the National Health Insurance has been successfully mapped to the GhanaCard which is a vital part of the health sector. In order to answer this question, the following sub-questions are asked:

- What are the technical requirements for implementing digital credentials in healthcare delivery in Ghana?
- What are the legal and ethical considerations for introducing digital credentials in healthcare delivery in Ghana?
- What challenges and opportunities exist to facilitate the introduction of digital credentials in healthcare delivery in Ghana?

The second research question focuses on the citizen's involvement, and the aim is to get a holistic understanding of how the people of Ghana would perceive the proposed change. Therefore, it is important to understand *how can citizen involvement in an interoperable healthcare system with the GhanaCard be achieved?* This question would further help attain the acceptability of the idea from the citizen's perspective.

This research aims to answer those two main questions, alongside the sub-question, through a qualitative expert interview analysis and a theoretical background, in order to gain a better understanding of the situation in Ghana and other developing countries. The findings of this research are expected to provide knowledge and recommendations to assist in addressing the challenges associated with healthcare facilities in silos, interoperability challenges of electronic health records, and inaccessibility of healthcare records by patients from both the private and public healthcare sectors.

## 1.3 Outline of the Thesis

This study has eight chapters. Chapter One of the study outlines the introduction and background of the use of the GhanaCard as a digital (including biometric) identification tool in healthcare. The researcher analysis the research problem, objectives, and research questions. Chapter Two of the study focuses on the literature review of the Republic of Ghana. Chapter three focuses on some theoretical concepts applicable to healthcare. Chapter Four focuses on the research methodology of the study. It describes the research design and strategy, the data collection procedures, and the analysis and validation. Chapter Five focuses on the research results and the analysis of the results. Chapter Six focuses on the discussion and recommendations. Chapter Seven discusses the limitations and future works, and finally, Chapter Eight focuses on the concluding summary of the study.

# 2. Literature Review

This literature review will explore the feasibility of using the GhanaCard to improve healthcare accessibility and interoperability in Ghana. In particular, it will analyze the effectiveness of the public key infrastructure (PKI) of the National Identification Authority (NIA) as a backbone for healthcare records, and the potential of the GhanaCard to improve accessibility and interoperability of healthcare records from both the private and public sectors. Additionally, the review will explore the impact of the GhanaCard on reducing the burden of manual data entry and eliminating the need for multiple identification cards in healthcare facilities. Finally, the literature review will examine the challenges and opportunities associated with the implementation of the GhanaCard in healthcare facilities, as well as the potential implications for healthcare stakeholders.

The GhanaCard is an identification card issued by the National Identification Authority of Ghana, intended for use by all citizens and legal residents of the country [17]. It serves as proof of identity and a way to access benefits, services, and other government resources. The GhanaCard was launched in 2017, with the main purpose of providing a secure and reliable means of identification. It is a credit card-sized card containing a microchip with personal information, such as name, gender, date of birth, and biometric data. The card also contains a unique 10-digit identity number. In addition, the card can be used to facilitate electronic payment transactions. As such, it provides a secure and reliable means of identification and authentication, as well as a way for citizens to access government services and benefits [18, 19].

In Ghana, the GhanaCard has been integrated with the National Health Insurance Scheme (NHIS) to improve healthcare service delivery. The card is being used to facilitate patient identification and verification at NHIS-accredited healthcare facilities, enabling patients to access medical care and services under the NHIS scheme. By using the unique identification number on the card, healthcare providers can easily verify patients' eligibility for NHIS coverage and access their medical records. The Ghana Health Service has implemented a digital system to track the attendance of healthcare workers, ensuring that patients receive care from qualified personnel. Similarly, the NHIS has integrated biometric identification to verify eligibility for healthcare coverage, reducing instances of fraud and improving the overall efficiency of service delivery [20]

## 2.1 Biometric data in healthcare delivery

The use of biometric data in healthcare delivery is becoming increasingly popular in developing countries such as Ghana. With a growing population and a shortage of healthcare providers, there is a need to streamline healthcare delivery and improve patient outcomes. Biometric identification systems are being used to help achieve this goal [21].

One example of biometric identification in healthcare delivery in Ghana is the GhanaCard, a national biometric identification system. The GhanaCard is being used to improve patient identification, reduce medical errors, and enhance the quality of care in healthcare facilities across the country. The card contains digital (including biometric) data such as fingerprints, facial recognition, and iris scans, which can be used to verify the identity of patients and healthcare providers [22, 23].

Several studies have been conducted to explore the use of biometric identification systems in healthcare delivery in Ghana [24]. These studies have shown that biometric authentication can increase the adoption of electronic health records, improve patient identification, and reduce the risk of medical errors. Biometric technology has also been found to enhance the quality of care, increase patient safety, and improve patient satisfaction [25].

However, the implementation of biometric identification systems in healthcare delivery in Ghana is not without challenges. Technical requirements such as the need for reliable internet connectivity and the availability of biometric scanners can pose challenges to the successful implementation of biometric identification systems. Legal and ethical considerations such as patient privacy and data protection also need to be taken into account [26].

Despite these challenges, there are opportunities to facilitate the introduction of digital identification systems in healthcare delivery in Ghana. Citizen involvement is key to the success of these systems, and efforts should be made to educate patients and healthcare providers about the benefits of digital identification systems. Interoperability between healthcare facilities is also important to ensure that patient data is accessible across different healthcare facilities [27].

To sum it up, the use of digital identification systems in healthcare delivery in Ghana has the potential to improve patient outcomes and enhance the quality of care. However, careful consideration of technical, legal, and ethical requirements is needed to ensure the successful implementation of these systems. With the right approach, digital (including biometric) identification systems can be an effective tool to streamline healthcare delivery.

## 2.2 Biometric data usage in the Ghanaian healthcare sector

On the usage of digital (including biometric) data in the Ghanaian healthcare sector, some studies show that there are potential benefits and challenges to biometric data usage. Dzisi examined the feasibility of biometric authentication for healthcare delivery in Ghana [28]. The study concluded that biometric authentication could improve healthcare delivery by enhancing patient identification, reducing fraud, and improving record-keeping. However, the authors also noted that biometric authentication requires significant financial investment and infrastructure, which may limit its adoption in resource-constrained settings like Ghana.

Another study by Abu-Maala examined the effectiveness of biometric identification in reducing medical identity theft in Ghana [29]. The study concluded that biometric identification could help prevent medical identity theft, which is a significant problem in the Ghanaian healthcare sector. However, the authors also noted that biometric identification systems must be carefully designed to protect patient privacy and prevent unauthorized access to biometric data.

A third study by Akuoko examined the perceptions of healthcare providers and patients regarding the use of biometric authentication in the Ghanaian healthcare sector. The study found that both healthcare providers and patients were generally supportive of biometric authentication, citing improved accuracy and reduced fraud as potential benefits [30]. However, the authors also noted that some healthcare providers expressed concerns about the potential for technical failures and the impact of biometric authentication on workflow [30].

A fourth study by Fosu examined the use of biometric data in managing chronic diseases in Ghana. The study concluded that biometric data could improve chronic disease management by providing real-time data on patients' health status and enabling targeted interventions. However, the authors also noted that there were significant technical and logistical challenges to implementing biometric data collection and analysis in the Ghanaian healthcare sector [31].

Finally, a fifth study by Abor examined the potential impact of biometric data on healthcare financing in Ghana. The study found that biometric authentication could improve healthcare financing by reducing fraud and improving record-keeping. However, the authors also noted that biometric authentication systems must be carefully designed to protect patient privacy and prevent unauthorized access to biometric data [32].

In conclusion, the usage of digital (including biometric) data in the Ghanaian healthcare

sector has the potential to enhance patient identification, reduce fraud, and improve record-keeping. However, the adoption of biometric authentication systems requires significant financial investment and infrastructure. Healthcare providers and patients generally perceive biometric authentication positively, but concerns about technical failures, workflow, and patient privacy remain. There are also significant technical and logistical challenges to implementing digital (including biometric) data collection and analysis in the Ghanaian healthcare sector. Nevertheless, biometric authentication has the potential to improve healthcare financing and chronic disease management in Ghana.

# 3. Healthcare Theoretical Concepts

The healthcare industry has been and still experiencing significant changes in recent times. One of the most pressing issues is the lack of integration or interoperability in healthcare facilities as seen in most developing nations. This fragmentation of healthcare services has been referred to as silos. The term "silo" implies that the healthcare industry is structured in a way that creates independent entities in this case health facilities, that function without coordination, leading to gaps in care and unnecessary healthcare costs.

To address the issue of silos in healthcare, several theoretical concepts have been developed to improve healthcare management and enhance the adoption of technology in the industry. These theoretical concepts include Vroom's Expectancy Theory - Healthcare Management, which focuses on motivating employees in the healthcare industry to increase productivity and efficiency, and The (Biometric) Technology Acceptance Model (BioTAM/TAM), which explores the factors that influence the acceptance and adoption of new technologies in healthcare. Additionally, A Framework for Accessing e-Health Preparedness Theory provides a comprehensive approach to assessing and improving the readiness of healthcare organizations to implement e-health technologies. These theoretical concepts have the potential to bridge the gaps in healthcare services and improve the quality of care provided to patients.

## 3.1 A Framework for Accessing e-Health Preparedness Theory

The "Framework for Accessing e-Health Preparedness Theory" is one that can help developing nations or organizations identify gaps and develop strategies to overcome barriers to successful e-health implementation. The researcher will analyze the issue of silos in healthcare facilities using the framework presented by Wickramasinghe on the five dimensions of the framework [9].

### 3.1.1 Technology: Infrastructure, Applications, and Security

**Infrastructure:** The infrastructure dimension encompasses the physical and digital assets and resources that support the delivery of healthcare services. In terms of physical infrastructure, healthcare facilities do face challenges related to capacity, accessibility, and reliability [9]. For example, rural and remote areas may have limited or inadequate facilities, equipment, and staff, which can, in turn, affect the quality and availability of care

for citizens or patients. However, in terms of digital infrastructure, healthcare facilities also face challenges related to connectivity, interoperability, and scalability [9]. For example, healthcare facilities may use different electronic health record (EHR) systems that are not compatible or do not communicate with each other, resulting in redundant or inconsistent data and processes [33].

**Applications:** The applications dimension encompasses the software and tools that support the delivery of healthcare services. In terms of clinical applications, healthcare facilities may face challenges related to usability, functionality, and interoperability [34]. For example, healthcare providers may use different clinical decision support (CDS) systems that offer conflicting or incomplete recommendations, leading to errors or delays in care. In terms of administrative applications, healthcare facilities may face challenges related to efficiency, accuracy, and compliance [35]. For example, healthcare administrators may use different billing and coding systems that generate inconsistent or incorrect claims, resulting in revenue loss or legal liability.

**Security:** The security dimension encompasses the measures and protocols that protect the confidentiality, integrity, and availability of healthcare information and systems. Healthcare facilities may face challenges related to data breaches, cyber-attacks, and privacy violations [36]. For example, healthcare facilities may store or transmit sensitive patient data using insecure or outdated methods, such as email or fax, which can be intercepted or leaked. Moreover, healthcare facilities may have different levels of compliance with legal and regulatory requirements related to data protection, such as the Health Insurance Portability and Accountability Act (HIPAA) [37].

The technology dimension of infrastructure, applications, and security offers a comprehensive framework for analyzing the challenges and opportunities of healthcare facilities in silos. By addressing the infrastructure, applications, and security needs of healthcare facilities, stakeholders can enhance the interoperability, efficiency, and security of healthcare processes and data. However, implementing and maintaining such technologies require substantial investments in resources, training, and governance. Therefore, a collaborative and strategic approach that involves healthcare providers, patients, payers, regulators, and technology vendors is essential for addressing healthcare facilities in silos.

### 3.1.2 Organizational: Governance, Leadership, and Human Resources

**Governance:** Effective governance is essential for healthcare facilities to work together towards common goals. According to Wickramasinghe, a governance structure that includes representatives from all relevant stakeholders is necessary to ensure accountability and transparency [9]. This structure must also allow for the exchange of information and communication to occur seamlessly between facilities. Effective governance is a crucial step in breaking down silos and promoting collaboration between healthcare facilities [9].

**Leadership:** Leadership is also crucial in promoting collaboration between healthcare facilities. Wickramasinghe suggests that leaders must create a culture that promotes collaboration and communication across facilities [9]. This culture can be achieved by setting clear expectations and goals for healthcare professionals, providing resources for training and development, and creating incentives for collaboration. Leaders must also be willing to listen to feedback and adjust their strategies accordingly to ensure that all stakeholders' needs are met.

**Human Resources:** Human resources are the backbone of healthcare facilities and play a critical role in breaking down silos. Wickramasinghe suggests that healthcare facilities should have a skilled workforce that is trained to work collaboratively with other facilities [9]. This workforce must have a good understanding of the governance structure, goals, and expectations set by leaders. They must also have access to technology and resources that facilitate communication and collaboration with other facilities.

In conclusion, "healthcare facilities in silos" is a significant problem in the healthcare industry, resulting in a lack of coordination and collaboration in patient care. To address this issue, organizational factors such as governance, leadership, and human resources must be considered. Effective governance that includes all relevant stakeholders, strong leadership that promotes collaboration and communication, and skilled human resources that are trained to work collaboratively are crucial in breaking down silos and promoting collaboration between healthcare facilities.

### 3.1.3 Legal and Regulatory: Policies, Standards, and Laws

The concept of "healthcare facilities in silos" operating in isolation, without effective communication or collaboration with governments or other healthcare entities cannot be without the mention of the legal and regulatory dimension which is one of the key factors

that affect the preparedness of healthcare organizations. According to the framework for assessing e-health preparedness by Wickramasinghe, it is stated that the legal and regulatory dimension plays a crucial role in addressing healthcare facilities' siloed nature [9]. The authors argue that policies, standards, and laws are essential for creating an interoperable and coordinated healthcare system. He further mentioned that the lack of proper legal and regulatory frameworks can lead to the fragmentation of healthcare services, duplication of efforts, and medical errors [9].

**Policies:** Policies are an essential aspect of the legal and regulatory dimension, which can facilitate the sharing of health information between healthcare facilities. For example, the Health Insurance Portability and Accountability Act (HIPAA) of 1996 was enacted to safeguard the privacy and security of patient health information while promoting the exchange of health information between healthcare providers. HIPAA's privacy rule, security rule, and breach notification rule provide a framework for healthcare providers to share health information securely while ensuring patient confidentiality [38].

**Standards:** Standards also play a significant role in addressing healthcare facilities' siloed nature, as they provide a common language for healthcare providers to exchange health information. For instance, the Health Level Seven International (HL7) standard provides a common language for electronic health records (EHRs) to communicate with each other, enabling a seamless exchange of patient health information [39].

**Laws:** Laws are another critical aspect of the legal and regulatory dimension that can facilitate the sharing of health information between healthcare providers. The 21st Century Cures Act of 2016 was enacted to promote the adoption of EHRs and the sharing of health information between healthcare providers. The act provides incentives for healthcare providers to share health information securely, promoting interoperability and coordination of healthcare services [40].

In conclusion, the legal and regulatory dimension, which includes policies, standards, and laws, plays a significant role in addressing healthcare facilities' siloed nature. By creating a framework for the sharing of health information between healthcare providers, policies, standards, and laws can promote interoperability, reduce duplication of efforts, and improve patient outcomes. However, policymakers must continue to monitor and update legal and regulatory frameworks to keep pace with the evolving healthcare landscape.

### 3.1.4 Clinical/Healthcare: Clinical Processes and Data Standards

In many parts of the world especially in developing economies, healthcare departments or facilities operate in isolation, leading to fragmentation of care, duplication of services, and inefficiencies in day-to-day activities. This problem is widely seen in healthcare processes and data standards. In this literature review, the researcher will explore the issue of healthcare facilities in silos through the lens of clinical processes and data standards, as described in A Framework for Assessing e-Health Preparedness by [9].

**Clinical Processes:** One of the main drivers of silos in healthcare is the lack of standardized clinical processes across facilities. Each healthcare facility may have its own protocols, workflows, and terminology, leading to inconsistent practices and difficulty in sharing information [41]. This can result in communication breakdowns, medication errors, and other adverse events, particularly during care transitions [42]. Therefore, it is important to establish standardized clinical processes that can be shared across different healthcare settings.

**Data Standards:** In addition to clinical processes, the lack of data standards also contributes to silos in healthcare. Different facilities may use different formats, codes, and terminologies to describe the same clinical information [43]. This can make it difficult to exchange information between different healthcare providers and systems, leading to incomplete or inaccurate patient records, missed diagnoses, and suboptimal treatment decisions [44]. Therefore, it is crucial to adopt data standards that ensure the interoperability and consistency of health information across different settings.

In conclusion, healthcare facilities in silos can have serious negative consequences for patient care and health outcomes. Clinical processes and data standards are two critical dimensions that need to be addressed to break down these silos. Standardized clinical processes can help to ensure consistency and quality of care across different settings, while data standards can facilitate the exchange and use of health information. Policymakers and healthcare leaders need to recognize the importance of these dimensions and invest in solutions that promote interoperability, collaboration, and patient-centered care.

### 3.1.5 Social and Cultural: Acceptance and Adoption

It is evident that the healthcare industry is shifting towards the adoption of electronic health records (EHRs) and other e-health technologies to improve patient care and outcomes. However, the success of these technologies is dependent on the acceptance and adoption

of healthcare professionals and patients. In this study, the researcher will explore the dimension of social and cultural factors in the context of healthcare facilities operating in silos.

**Social and Cultural Factors:** The success of e-health technologies is dependent on the acceptance and adoption of healthcare professionals and patients. Social and cultural factors play a significant role in the acceptance and adoption of these technologies. Healthcare professionals or experts are more likely to adopt e-health technologies if they perceive them as easy to use and beneficial to their patients [45]. However, on the other hand, patients are more likely to adopt and use these technologies if they are given the assurance or if they perceive them as secure and privacy-protected [46].

Healthcare facilities that operate in silos may face challenges in the acceptance and adoption of e-health technologies. In a siloed healthcare system, different departments may use different technologies, and there may not be a unified system for sharing patient data. This can lead to frustration among healthcare professionals who have to use different systems for different tasks [47]. Patients may also be hesitant to adopt e-health technologies if they perceive them as incompatible with their cultural beliefs or if they have concerns about the security and privacy of their data [48].

Social and cultural factors play a significant role in the acceptance and adoption of e-health technologies. Healthcare facilities that operate in silos may face challenges in this regard. To overcome these challenges, healthcare organizations should focus on creating a culture of collaboration and communication, implementing technologies that are user-friendly and compatible with cultural beliefs, and ensuring the security and privacy of patient data.

### 3.1.6 Related Works - A Framework for Accessing e-Health Preparedness

**China:** A study conducted by Li, Junhua, et al aimed to assess the e-health preparedness of healthcare facilities in China during an influenza pandemic [49]. The study was conducted using a qualitative approach, and data were collected through focus group discussions with healthcare workers and key informant interviews with public health officials [49].

The study found that although the e-health system in China has improved in recent years, there are still challenges that need to be addressed to improve the e-health preparedness of healthcare facilities during an influenza pandemic. One of the main challenges identified was the lack of a standardized and integrated e-health system, which hindered the sharing

of information and coordination among healthcare facilities. In addition, the study found that there were significant gaps in the knowledge and skills of healthcare workers regarding the use of e-health technologies, which could compromise the effectiveness of e-health interventions during an influenza pandemic.

The study recommended several strategies to improve the e-health preparedness of healthcare facilities in China during an influenza pandemic. These included the development of a standardized and integrated e-health system, the improvement of the knowledge and skills of healthcare workers regarding the use of e-health technologies, and the enhancement of communication and collaboration among healthcare facilities.

Overall, the findings of this study highlight the importance of e-health preparedness in the context of an influenza pandemic and the need for ongoing efforts to improve the e-health system and the knowledge and skills of healthcare workers to ensure effective responses to pandemics.

**Iran:** A study conducted by Rezai-Rad et al, aimed to present a framework for assessing the readiness of the Iranian healthcare system to adopt e-Health technologies [50]. The authors conducted a comprehensive review of the literature on e-Health readiness assessment and developed a framework consisting of six domains and 36 sub-domains. They then applied the framework to assess the e-Health readiness of three Iranian healthcare organizations. The results indicated that the organizations had a low level of e-Health readiness, particularly in the areas of technical infrastructure, legal and ethical issues, and financial resources. The authors concluded that the framework could be used by policymakers and healthcare organizations to identify areas that need improvement in order to facilitate the successful implementation of e-Health technologies in Iran.

## 3.2 Vroom's Expectancy Theory - Healthcare Management

Vroom's Expectancy Theory is a motivation theory widely applied in various industries including healthcare. The theory suggests that an employee's, in this case, a citizen's motivation to perform a task is determined by three key factors: expectancy, instrumentality, and valence. Expectancy refers to the citizen's belief that their effort will lead to improved performance, instrumentality refers to the citizen's belief that improved performance will lead to desirable outcomes, and valence refers to the value the citizen places on the desirable outcomes [51].

In the healthcare context, this means that patients or citizens are more likely to engage in behaviors that they believe will improve their health outcomes. For example, if a patient

or citizen believes that by presenting their national ID card to any health facility, in their home country, they could be given the best care because all their medical history is readily available and can be accessed at any time which could lead to improved health outcomes, they will be more motivated to do so. Similarly, if a citizen believes that engaging in healthy behaviors such as regular exercise and a balanced diet will lead to improved health outcomes, they will be more motivated to engage in these behaviors.

According to Vroom's expectancy theory which suggests that an individual's motivation to use new technology is based on their expectations of the outcomes of their actions [51]. If healthcare practitioners do not believe that their organization is providing adequate data protection, they may not expect that their efforts to use the system will result in successful outcomes. This lack of belief in the positive correlation between their efforts and the system's performance could reduce their motivation to adopt the system and hinder its successful implementation [51].

According to this theory, citizens' or patients' motivation to engage in behaviors will be influenced by their belief that the behavior will lead to a desired outcome and the perceived value of that outcome [51].

### 3.2.1 Related Works - Vroom's Expectancy Theory in Healthcare

**Italy:** The study by De Simone discusses the importance of understanding the motivation of healthcare workers and presents a study that aimed to develop a tool to assess the motivation of healthcare workers in Italy [52]. The authors argue that healthcare workers are key resources for providing quality care and that understanding their motivation is essential for maintaining a high level of service. The study involved the development of a questionnaire based on Victor Vroom's Expectancy Theory, which posits that motivation is based on an individual's beliefs, perceptions, and probability estimates. The questionnaire was administered to a sample of healthcare workers, and the results showed that it was a reliable and valid tool for assessing motivation in this population. The authors conclude that the tool could be used by healthcare organizations to better understand and support the motivation of their workers, ultimately leading to improved patient outcomes.

## 3.3 The (Biometric) Technology Acceptance Model (BioTAM/TAM): Bridging the Siloed Nature of Healthcare

Healthcare is a complex system, often characterized by siloed departments, which has led to fragmented care and inefficiencies. Bridging these silos has become increasingly important

in improving patient outcomes and reducing costs. The Technology Acceptance Model (TAM) and Biometric Technology Acceptance Model (BioTAM) have been proposed as frameworks to better understand the acceptance and use of technology to bridge these silos.

The Technology Acceptance Model (TAM) has been widely used in healthcare to understand the acceptance and adoption of new technologies. In a review of 85 scientific publications, TAM was found to be used in three main categories: TAM literature reviews, development and extension of TAM, and modification and application of TAM [53]. One study found that telemedicine applications were the most frequently studied area using TAM between 1999 and 2017, highlighting the challenge of acceptance of this technology in developing health service organizations during that period [54].

This theory can support the challenges users or patients are likely to face in the implementation of GhanaCard being used to bridge siloed nature in the healthcare setting is the Technology Acceptance Model (TAM). TAM is a widely used theory that explains the factors influencing the acceptance and use of new technologies. It proposes that perceived usefulness (PU) and perceived ease of use (PEOU) of technology are the two main factors that influence an individual's intention to use new technology [54].

In the context of healthcare, TAM can be useful in identifying the challenges that citizens or patients are likely to face in the adoption of new technologies. For example, if a new technology is perceived as difficult to use or not useful, citizens or patients may be reluctant to adopt it, so by understanding the factors that influence the acceptance and use of new technologies, the government of Ghana the Ministry of Health can develop strategies to address these challenges and promote the successful implementation of GhanaCard to be used to access medical health records regardless of the health facility.

According to Rahimi et al, the perceived usefulness and perceived ease of use of the system are crucial factors in determining individuals' acceptance and intention to use new technology [54]. If healthcare practitioners are not convinced that their organization's data protection level is adequate, they may perceive the system as not useful, which could reduce their intention to use it. Additionally, if the system is perceived as too difficult or time-consuming to use, healthcare practitioners may be less likely to adopt it, even if they see the potential benefits.

Overall, the literature on TAM and its application in healthcare indicate that the model can be useful in bridging the siloed nature of healthcare. By understanding the factors that influence the acceptance and adoption of new technologies, healthcare organizations can better integrate technology across departments and systems. However, the application of

TAM in healthcare requires careful consideration of the specific context and factors that may impact acceptance and adoption, such as patient preferences, provider attitudes, and organizational culture [55].

On the other hand, BioTAM is a newer framework that expands upon TAM by considering the role of trust in technology acceptance. BioTAM includes two additional constructs: perceived security and perceived privacy. Perceived security refers to the degree to which a user believes that their personal information is protected, while perceived privacy refers to the degree to which a user believes that their personal information is not disclosed without their consent. One study found that BioTAM was effective in predicting the acceptance of biometric authentication technology in healthcare settings [56].

Biometric technology has become increasingly prevalent in various industries, including healthcare, due to its ability to enhance security and privacy. The biometric technology acceptance model (BioTAM) has been proposed as a way to predict and improve user acceptance and adoption of biometric technologies [57]. In healthcare, the implementation of biometric technology can potentially bridge the silos and gaps in healthcare by enabling secure and efficient sharing of patient data among healthcare providers [58]. However, the success of biometric technology adoption in healthcare depends on the acceptance of the technology by healthcare providers and patients.

The BioTAM has been applied to the healthcare industry to explore the factors that influence the acceptance of biometric technology. The BioTAM includes the traditional Technology Acceptance Model (TAM) constructs of perceived usefulness (PU) and perceived ease of use (PEOU) as well as the additional constructs of perceived security and privacy (PSP) and perceived enjoyment (PE) [57].

Studies have shown that PU and PEOU have a significant effect on the intention to use biometric technology [57]. Additionally, PSP has been found to be a crucial factor in the acceptance of biometric technology in healthcare, given the sensitivity and confidentiality of patient data [58]. Finally, PE has been identified as a potential factor that can enhance user acceptance and adoption of biometric technology in healthcare [57].

Overall, the BioTAM has proven to be a useful model in predicting and improving user acceptance and adoption of biometric technology in healthcare. Further research can help identify additional factors that influence the acceptance of biometric technology, especially in the context of healthcare silos and gaps.

### 3.3.1 Related Works - The Biometric or Technology Acceptance Model (TAM)/(BioTAM)

The Technology Acceptance Model (TAM) and its extension, the Biometric Technology Acceptance Model (BioTAM), have been widely studied in the healthcare domain. Below are some related works and findings for both models:

**TAM in healthcare:**
A study on the acceptance of electronic health records (EHRs) among healthcare professionals found that perceived usefulness and ease of use, as defined by TAM, were significant predictors of EHR adoption [59].

Another study examined the acceptance of telemedicine among patients and found that perceived usefulness, ease of use, and subjective norms were significant predictors of patients' behavioral intentions to use telemedicine services [60].

A systematic review of TAM in healthcare concluded that the model is a useful tool for understanding the acceptance of health IT and identified several factors that affect users' perceptions of usefulness and ease of use, such as system quality, information quality, and user characteristics [61].

**BioTAM in healthcare:**
The study aimed to propose a new technology acceptance model (BioTAM) for biometric authentication systems. The proposed model was developed based on the Technology Acceptance Model (TAM) and incorporated the perceived risk factor. The study used a survey to collect data from 131 participants who had used a biometric authentication system. The results showed that the proposed model had a high level of reliability and validity, and perceived usefulness, perceived ease of use, and perceived risk were significant predictors of user intention to use the biometric authentication system. The study concludes that the proposed BioTAM model could be used to evaluate user acceptance of biometric authentication systems and could help in the development of more effective biometric authentication systems [56].

# 4. Research Methodology

In order to achieve the aim and objective of this study, this chapter will delve into the most appropriate research methodology and present the methods and techniques used to conduct it. The underlying blueprint for this section includes the research design and strategy, data collection procedures, and data analysis and validation. The data collection procedures entail the population of the study, sources of data (primary and secondary), and data collection. Finally, data analysis and validation are made of sample and sampling techniques, data analysis, tests for validity and reliability, and ethical considerations. These will be further discussed in the subsections that follow

## 4.1 Research Design and Strategy

Research design is a term used to describe the blueprint or map that directs the conduct of any study [62]. It is the framework used to identify the purpose of the analysis, the methods that will be used to collect and analyze the data, and the factors that will be taken into account in the analysis. Research designs can be exploratory, descriptive, causal, or a combination of these for a particular study [62]. The study will therefore follow a case study research process as shown in the diagram below.

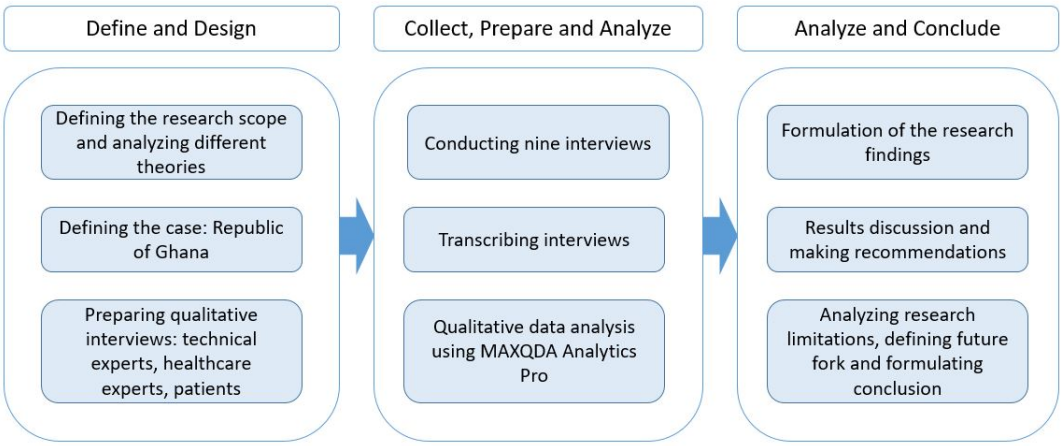


Figure 1. Conducting a Case Study
[63]

Different authors classify research designs differently [62]. The most commonly used types of designs are cross-sectional design (also known as survey design), longitudinal design, experimental design, comparative design, and case study design [64]. Each type of design has its own set of advantages and disadvantages [64]. While there is no single

ideal research design [64, 65], certain designs may be better suited for certain contexts. For instance, experimental designs are used to estimate causal effects, and case studies are used to gain an in-depth understanding of a single phenomenon [66].

No matter what kind of research design is chosen, it is important that the researcher evaluates the design to make sure it is appropriate for the research questions, feasible, and that it produces valid and reliable results [65].

Case study research design is one of the extensively used qualitative research methods that involves an in-depth investigation of a particular phenomenon within its context. According to [67], case study research design is used in various fields of social sciences such as sociology, management, anthropology, psychology, etc. The research design requires researchers to make important decisions about research objectives, data collection methods, sampling methods, and the selection of subjects.

Primary data is data that is collected by researchers through methods such as observations, surveys, or interviews and is used to answer specific research questions [62]. Secondary data, on the other hand, is data that already exists and was collected by other researchers or organizations. It can provide valuable background information and context for a research study [65].

It is in line that this study aimed to investigate the challenges such as siloed healthcare facilities, interoperability issues, and inaccessible health records that continue to impede progress toward a comprehensive healthcare system, the descriptive and case study research designs were adopted in line with a qualitative approach were chosen for this study.

A comprehensive research strategy involves several key steps that must be followed to ensure the validity and reliability of the research or study. There are some steps that must be followed, first step is to clearly define the research question or problem that the study seeks to address [68]. Next, the selection of an appropriate research design and methodology will allow for the collection of data that can be used to answer the research question. This may involve using qualitative or quantitative methods, or a combination of both [62]. The next step is collecting and analyzing the data, using appropriate statistical or qualitative analysis techniques [62]. And finally, the interpretation of the results of the analysis and drawing conclusions that address the original research question [68]. It is important for researchers to follow ethical guidelines throughout the research process, which includes, obtaining informed consent from study participants and ensuring the privacy and confidentiality of any data collected [69].

## 4.2 Data Collection Procedures

In healthcare research, a study population is defined as a group of individuals who share a common characteristic or experience and are the subject of the research study. According to [70], defining the study population is a critical step in designing and conducting qualitative research in social work. The study population can be any group, including patients, healthcare professionals, or community members.

The study population is important in healthcare research because it determines the generalizability of the study results to a larger population. Population-based studies aim to answer research questions for defined populations and the findings should be generalizable to the whole population addressed in the study hypothesis, not only to the individuals included in the study [71]. In this study, healthcare professionals, National Identification Authority personnel, and patients or citizens account for a total of 9 respondents.

In every research, data sources are essential in that research work as they form the basis for the analysis, as well as the decision-making. For this research, the primary and secondary sources of data were used to provide the foundation.

This study used three sets of interviews as its primary source of data in order to gain an understanding of views from NIA experts, health experts, and citizens regarding the viability and benefits of connecting the GhanaCard to healthcare facilities. This data and information were collected directly from respondents within the NIA, healthcare professionals across Ghana, and citizens or patients.

According to [72], secondary data analysis refers to the practice of analyzing an existing dataset to generate new interpretations, conclusions, or knowledge beyond those presented in the original report. This method can provide researchers with valuable insights and findings, particularly when combined with other research methods. In healthcare, secondary data sources can be used to answer research questions, generate hypotheses, and support evidence-based practice [73]. In this thesis, however, reports, articles, journals, and grey materials were used as secondary data for this study.

Data collection is the process of gathering and measuring information on targeted variables of interest, typically to support research, decision-making, or monitoring of a specific phenomenon or system [74]. The study employed self-designed interview questions. It was crucial as it would guarantee precise and cost-effective data collection.

The study used interviews as the primary method of empirical data collection. The

interviews were divided into three parts or groups namely NIA experts, Healthcare Experts, and citizens or patients. All three parts were open-ended in nature, which allowed the respondents the liberty to freely express themselves in respect of the information required.

The interviews were conducted via an online medium (Zoom and Microsoft Teams) with all the respondents from the three groups. The research informed the experts at NIA three months prior to the interview dates to explain the purpose of the study and assure confidentiality for the eventual approval of the study to be conducted. The data collection period lasted approximately six weeks and was carried out by the researcher.

## 4.3 Data Analysis and Validation

According to Neuman Lawrence, the importance of determining an appropriate sample size and sampling technique in social research should be sufficient to provide a representative sample of the population, but also feasible in terms of time and resources [75]. He also discussed the various sampling techniques available and the strengths and weaknesses of each. He emphasizes the importance of selecting a sampling technique that is appropriate for the research question and population of interest. The choice of sample size and sampling technique should be carefully considered to ensure that the research results are valid and reliable [75].

In this study, the researcher used a total of 9 respondents which were made up of technical experts, healthcare experts, and patients or citizens all from Ghana; because the targeted group is anticipated to have a high degree of homogeneity, selecting 9 samples in total is considered a reasonable representation of the research population. This sample size was chosen to provide optimal information from the sample, which can be extrapolated to the wider population under investigation.


Figure 2. Structure of population sample to be used)

Data analysis is an important step in research methodology. It involves the collection and interpretation of data in order to answer a question or test a hypothesis. According to [76], data analysis typically involves four main steps: data collection, data organization, data interpretation, and data presentation. During data collection, the relevant information is gathered from a variety of sources, such as interviews.

[77] described content analysis as a process of classifying all data collected during a research study, including both verbal and behavioral observations. Content analysis can be carried out through a description of the data collected data. Additionally, the analysis should be conducted in a transparent manner so that readers can understand the process and the results. The content analysis of this study was done by transcribing the interview recordings and categorizing them according to the conceptual framework of the study using MAXQDA Analytics Pro.

To ensure the validity and reliability of the study's findings, three sets of focus groups were employed - experts from the NIA, healthcare professionals from different facilities, and some citizens (patients). All of the transcribed information from the interviews was documented and emailed to the participants to review and verify the accuracy of the interviews. This process was done to demonstrate the validity of the findings. Additionally, the research findings were summarized in order to make them transferable to readers and comparable to a similar group.

All information and data collected for this study were treated with the utmost confidentiality in order to eliminate any threats associated with the expressed views. Before beginning the interview, participants were informed that the focus was on the information and not the informant. Furthermore, participants were asked to provide their names for the record in order to demonstrate their consent. To protect the primary data collected through the interviews, it was uploaded to external memory drives.

# 5. Research Results

This chapter deals with the presentation, analysis, and discussion of data collected during the interview. The adequacy of the responses was assessed for completeness and reasonableness. These will be systematically arranged and analyzed for comprehensive interpretation and making reliable conclusions.

## 5.1 Background Characteristics of the Respondents

In this section, the background characteristics of the three groups were analyzed and presented based on the interview (age, gender, duties, and job responsibilities) with all respondents or interviewees.

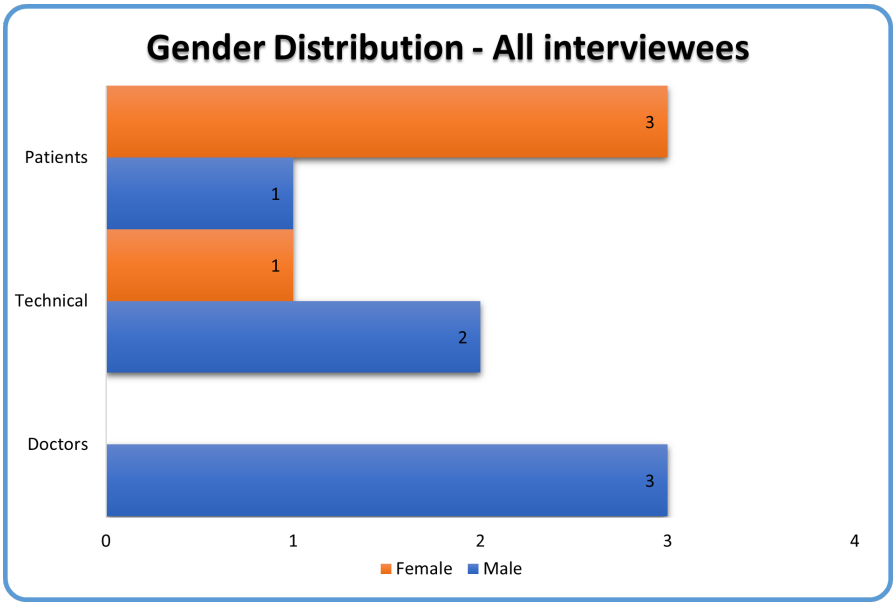


Figure 3. Gender distribution of all interviewees

| | Male | M % | Female | F % |
|---|---|---|---|---|
| Doctors | 3 | 50% | | 0% |
| Technical | 2 | 33% | 1 | 33% |
| Patients | 1 | 17% | 2 | 67% |
| **Total** | **6** | 100% | **3** | 100% |

Figure 4. Gender distribution of all interviewees (tabular)

Figures 3 and 4 shows the gender distribution of the overall interview conducted; there were 67% males as compared to 33% females. This does not necessarily have a direct

impact on the analysis. From the group-level gender distribution, there were 100% male doctors with no females, 67% male technicians with females making up 33% technicians, and finally, patients or citizens had 67% more females as compared to 33% males.

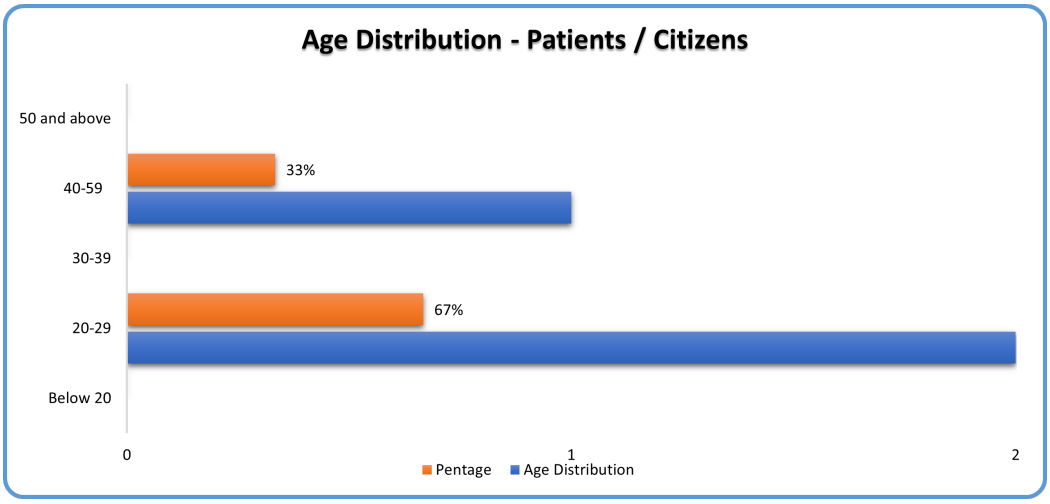


Figure 5. Age distribution of all interviewees

Figure 5 shows the age distribution of all participants from the patients or citizen group; 67% constituting a majority of the participants from the 20-29 cohort and 33% from the 40-59 group.

## 5.2 Usage, Experience, and Future Expectations for the GhanaCard


Figure 6. Word cloud - frequency of words used

Figure 6 above shows the most word that repeats within all three sets of interviews conducted with the technicians, doctors, and citizens. From the figure, one can see that

GhanaCard, medical, data, information, patient, records, confidentiality, etc. are the most used words.

### 5.2.1 Patients or Citizens - Usage

| Usage | Patient 1 | Patient 2 | Patient 3 | Percentage |
|---|---|---|---|---|
| Bank | Yes | | Yes | 67% |
| SIM registration | | Yes | | 33% |
| SSNIT | | Yes | Yes | 67% |
| TIN | | Yes | | 33% |
| NHIS | | | Yes | 33% |
| Medical service | Yes | Yes | Yes | 100% |
| Paper based system | | | Yes | 33% |

Figure 7. Usage of the GhanaCard in other sectors

From Figure 7, 67% of all patients interviewed said they had used the GhanaCard to perform bank authentication and transactions, 33% used it for mobile SIM card registration, 100% used it for medical service at least once, and also to confirm or give assurance of having public health insurance which is the NHIS. 100% of the patients have attended healthcare where a paperless hospital management system is used to manage their health records, with just one participant (33%) also encountering a paper-based system with some challenges.

### 5.2.2 Patients or Citizens - Experience

| Experience | Patient 1 | Patient 2 | Patient 3 | Percentage |
|---|---|---|---|---|
| Medical use frequency | 1 a month | 3x a year | 2x a year | 100% |
| Paperless system | Yes | Yes | Yes | 100% |
| Challenges with paper based system | | | Yes | 33% |
| Challenges with paperless system | No | No | No | 0% |
| Application of sufficient data protection measures | Yes | No sure | yes | 67% |
| Request for view of health records | Yes | No | Yes | 67% |
| What was your experience? | Positive | | Positive | 67% |

Figure 8. Personal experiences in healthcare sectors

Figure 8 shows 100% personal experiences with frequenting medical facilities as well as 100% encounter with a paperless system; although one person (33%) had also experienced some challenges with a paper-based health facility system. Aside from that, all participants (100%) had no challenges with a paperless health management system.

On the front of whether there have been sufficient data protection measures applied to their health records in their various health facilities, the participants responded as such, as

captured in the table below:

| | **Patient 1** | **Patient 2** | **Patient 3** |
|---|---|---|---|
| Q6 | *"Yes, I believe so because it's a private hospital and their services are top-notch; also, I have known them for over 10 years now. So, there's no way I would have issues with my data or my health record being leaked or someone having access to it without any legal backing."* | *"Aside from the computers that the doctors were using, the ones at the OPD, where they take your details, were in an area where it was enclosed for just staff only, so if you're not a staff you can't enter that area, however, I don't think it's a place where no one can enter; it's not a highly secured place that will be difficult for anyone, during the cover of night anyone can easily make their way there but at least it's in a confined area, especially for staff."* | *"But in the other place that I went that I wasn't given a folder, I'm very sure your information is secured. It will be on the laptop, or nobody will see whatever has been written about you, and I think it's quite good."* |

Table 1. Application of sufficient data protection measures

Secondly, on the front of participants requesting to have a view of their medical health records within *(Q9)* or outside *(Q9b)* the facilities, 67% who responded had these responses as shown in the table below :

| | **Patient 1** | **Patient 2** | **Patient 3** |
|---|---|---|---|
| Q9 | *"Yes, I've done that before. I think that was the last two months I did that, they show it to me. So what I realized was that I thought the hospital had its laboratory facility, but rather it was a private provider laboratory working within the hospital. So, when I requested my laboratory statement, they showed it to me."* | | *"Oh yes. I was going for an interview, and I had to take some lab tests. I went to the hospital; they did lab tests for me. I had to go with my results to the interview center, so I requested that for it and they give the reports to me. I didn't go through any difficulty, they just printed a copy for me when I told them I needed my reports."* |
| Q9b | "*However, it's not possible to get outside the facility unless maybe a doctor requests it then they will send it to the doctor who requested it with my consent."* | | *"But the second place that I went, they had all the information on the computer; you can't have access to any information about yourself. It is only at the facility level or wherever you went to the hospital that they keep such information"* |

Table 2. Request to view medical health records within and outside health facility

### 5.2.3 Patients or Citizens - Future Expectation (Optimism)

In addition to all the experiences expressed by the participants, a 100% (Figure 9 and Table 3) said they will be comfortable using their GhanaCard to access their medical records from all health facilities be it hospitals, clinics, pharmacies - public or private should it be implemented. In this case, as per Vroom's theory, the implementation of the GhanaCard as a tool can be presented as the effort required to achieve the goal of improving healthcare in the country.

| Optimism | Patient 1 | Patient 2 | Patient 3 | Percentage |
|---|---|---|---|---|
| Comfortability using GhanaCard to access health facilities | Yes | Yes | Yes | 100% |
| Expectation using GhanaCard in the Healthcare sector | Positive | Positive | Positive | 100% |
| Possibility to see health records outside the facility | No | No | No | 100% |
| Foreseeable benefits of using the GhanaCard as a tool | Positive | Positive | Positive | 0% |
| Do you think that could improve the overall healthcare system | Yes | Yes | Yes | 100% |
| Maintenance of patient-doctor confidentiality | Yes | Not sure | Yes | 67% |

Figure 9. Patients being optimistic

| | Patient 1 | Patient 2 | Patient 3 |
|---|---|---|---|
| Q7 | *"Yes, I would be comfortable because, for authentication's sake, probably someone might use my identity to see a specialist or something like that. So, with my GhanaCard, because I have my bio-data on it, they'll be able to verify that it's Aba using it or someone trying to impersonate Aba, so I'll be okay with that. Because I have had an experience with the NHIS card, I once received a message from a particular pharmacy that my purchase with my NHIS card has been successful, so I should go somewhere for the medication."* | *"Well, I'm okay and I'll be happy or comfortable using the GhanaCard in that regard because in a case where I'm unable to tell the doctor or anybody giving me care about myself, they will be able to easily access it, I'll be happy about."* | *"OK, I'll be very comfortable with it; if we can use the GhanaCard to access healthcare everywhere. It will make health delivery, accessing health delivery very, simple for some of us, because when you go, you wouldn't have to wait in that long queue and wait till the link comes up, wait till they look for your folder, or fill a form for a folder which is not an easy job. So, I think when that thing is done, it will ease the burden on us."* |

Table 3. Comfortable using the GhanaCard to access health facilities

Furthermore, according to Vroom's expectancy aspect of motivation, 100% of the patient or citizens are of high positive expectations using the GhanaCard when it is used to bridge the siloed nature of healthcare facilities in Ghana as captured by some of the participants - *"OK, I'm just praying that this GhanaCard should at least help them be able to bridge*

*the gap between taking folders from here to the pharmacy, to the lab, here and there, to this place. I think this GhanaCard would be able to bridge such a gap when it comes, and it will make work easier, for example, maybe during emergencies, when they need information from you; I think it would also make it quicker"*; another participant said this: *"I expect that it would be enforced, that is, every citizen would come on board to merge the GhanaCard and the NHIS to make accessibility of healthcare very easy for everyone."*

Additionally, 100% of all the participants are optimistic with a positive attitude towards seeing the GhanaCard being used to bridge all healthcare facilities in Ghana. People naturally tend to go back to the same place they get their healthcare without any choice, and this is typical in Ghana. The table shows what patients or the citizens had to say:

| | **Patient 1** | **Patient 2** | **Patient 3** |
|---|---|---|---|
| Q10 | *"It will be easy to access healthcare anyway you find yourself."* | *"If the GhanaCard is used for that easy accessibility of health records, then it'll help facilitate healthcare provision because various healthcare facilities will have access to the records of the patients thereby being able to determine what the particular issue the patient is having or what medical history the patient is having so they can know the particular type of care to give the patient."* | *"Oh OK, I think if the GhanaCard is used to bridge that, it will help us get better healthcare. If I say better healthcare, I mean you will be able to avoid the long queue or time that you need to spend there, I think it will be a thing of the past. And also, I think when you go, you wouldn't have to be doing certain things all over again and you wouldn't be asked some questions that you have already been asked and at one facility all over again."* |
| Q10 | | *"...doctors have a funny way of writing, sometimes when they give you a prescription to the pharmacy, some pharmacists are unable to read; so having a system such as this, where the pharmacist can easily access it, will make it easier for the pharmacist to give you medication that would heal you rather than kill you."* | |

Table 4. Foreseeable benefits of using the GhanaCard as a tool

On the question of whether the bridging of all health facilities in the country (Ghana) could improve the overall healthcare system, below are responses from the participants (100%) Table 5. According to Vroom's expectancy aspect of motivation, in this case, optimism, which is 100% for all participants, the theory's instrumentality refers to the citizen's belief that improved performance (bridging the gap) will lead to a desirable interoperable healthcare system.

| | **Patient 1** | **Patient 2** | **Patient 3** |
|---|---|---|---|
| 10a | *"Yes because anywhere you find yourself with your GhanaCard, the health facility could access your medical records to get information about what you're allergic to, the kind of aid to give you, etc to be able to give you the best care or attend to you."* | *"Definitely, assuming I was sick in one region, and the very clinic I'm taken for care can't assist me fully, and they transfer me to a bigger hospital in Accra, there's no way that hospital wouldn't be able to assist me; all I'll have to do is to give them my GhanaCard and they'll be able to access all the notes or medical records the clinic had previously written about me before the transfer and be able to continue the care for me; in this case, there wouldn't be anything like go and bring is file, records, etc"* | *"Oh yes, as I explained earlier if it's used to link it will improve the overall healthcare system in the country because, as I said earlier when you go to the hospital all your information will be readily available there."* |

Table 5. Overall improvements in healthcare in Ghana

Finally on the optimism front, only 67% gave positive feedback on the question about maintenance of patient-doctor confidentiality; although there was one participant who was not sure; Table 6 gives a full brief of their responses:

### 5.2.4 Healthcare Experts - Experience

The table below (Table 7) gives the current position, responsibilities, and duration in the healthcare sector of the following experts. The longest-serving health expert (2) has been in the field for over thirteen years with myriad expertise. When asked about their experience with the GhanaCard, there was a 100% response with each having the below to say: Expert 1 had this to say about his experience with the GhanaCard "Applying for the GhanaCard was easy for me probably due to my position because they realized I am an essential worker; immediately I got to the station where it was being processed they recognize me and then quickly worked on the various registration process for me so that I could quickly go back to continue my work; so I think I had it quite easy".

| | Patient 1 | Patient 2 | Patient 3 |
|---|---|---|---|
| 11 | *"Yeah, because before a doctor gets to access my health records, the doctor would need my consent, be it a private or public institution, so I think, it would maintain patient-doctor confidentiality."* | *"It could, only if the data doesn't go into the wrong hands or only if the other health facilities could protect my data. Well, let me bring back my little IT knowledge. Yes in some sort of way, you know every system has a backend, and people can have access to the backend information, even if it's not hackers, people have genuine access to it. Yes the doctor-patient confidentiality between the two of them can be kept, but how about the people who have access to the backend? Systems must be put in place to check that people will not have access to other people's information on the system"* | *"Oh, yes. When it's linked, it will improve the confidentiality level because where the folders are or where they keep the folders are, you might not know who might pick a particular folder; you see, maybe your relative will just be picking a folder at random and might pick your folder and will go through and say hey I know this person, he has this kind of disease; but when this thing is linked, I think it wouldn't be just easy for anybody to get into the system to know what exactly is happening I think. It will help."* |

Table 6. Maintenance of patient-doctor confidentiality

| Experience | HC Expert 1 | HC Expert 2 | HC Expert 3 | Percentage |
|---|---|---|---|---|
| Paperless system | Yes | Yes | Yes | 100% |
| Paper-based system | No | Yes | Yes | 67% |
| Q4. Retrieval and authentication the healthcare records | Yes | Yes | Yes | 100% |

Figure 10. Healthcare expert experience with a Hospital Management System

Expert 2 had this to say: "Main experience was, difficulty with registering, finally getting it registered. Activating your SIM cards so that you don't get your Subscriber Identity Module (SIM) cards deactivated. So yeah, lots of experiences with regards to actually getting the GhanaCard and then following that is just basically being used as your main identification tool everywhere you go." finally expert 3 had this to say: "I've had numerous experiences, you need to link your GhanaCard to your bank account, you need to link it to your mobile device, you need to link it to your Social Security and National Insurance Trust (SSNIT) and so on; I mean everything we are doing now has been the GhanaCard, which means that I've had numerous encounters even applying for the passport you need, the GhanaCard, in addition, I mean as one of the proofs of identities, so I've heard a lot of encounters with the GhanaCard."

When asked about the healthcare experts' experience with the use of a management system

| | Health expert 1 | Health expert 2 | Health expert 3 |
|---|---|---|---|
| **Positions** | ■ Senior medical officer<br>■ Medical director (Hope Hospital) | ■ Consultant physician (internal medicine)<br>■ Senior lecturer (medicine and therapeutics)<br>■ Head of dialysis unit (Korle-Bu)<br>■ Academic researcher | ■ House officer (surgical rotation) |
| **Duration** | 7 years | 13 years | 2 years |
| **Duties** | ■ Clinical works<br>■ Coordination of medical officers' affairs<br>■ Coordination of clinical facility affairs | ■ Clinical works (kidney)<br>■ Clinical works (emergency and OPD) | ■ Surgery<br>■ Obs and Gyne<br>■ Pediatrics |

Table 7. Credentials of the various healthcare experts

within their various facilities, there was a 100% percent (Figure 10) affirmative response; however, expert 2 who works in one of the biggest teaching hospital (Korle-Bu) claimed that the facility had about 90% of the paper-based system moved to an online health management system. The reason for the remaining 10% is that sometimes when there is a break in connectivity which is usually internet connectivity issues, they resort to the paper-based system. On the brighter side however, a government-owned healthcare management system is currently being rolled out as captured by expert 3: "Alright, so with the teaching hospital, what I realized was we use a software called the LHIMS software" and "Now when you come to the district facility as well, some facilities use the Health Pro System". This was however, also confirmed by health expert 1 in his closing remarks: "Currently, there is a paperless system Lightwave Health Information Management System (LHIMS) that is being rolled out, but I don't know whether it's being rolled throughout the country. It has been introduced to my facility by the Ministry of Health, although we are using different software."

With a full management system running in their respective health facilities, the question about how the patient health records are retrieved and authenticated, all (100%) the health experts said it was either by a small card they give to the patients, or through the NHIS card which has been linked to the GhanaCard.

### 5.2.5 Healthcare Experts - Future Expectation (Optimism)

| Optimism | HC Expert 1 | HC Expert 2 | HC Expert 3 | Percentage |
|---|---|---|---|---|
| Q6. Potential benefits of implementing the GhanaCard as tool | Yes | Yes | Yes | 100% |
| 6a. Reduce the burden of paperwork or address other challenges | No | Yes | Yes | 67% |
| Q7. Accessing the readiness of your organization | Yes | Yes | Yes | 100% |
| Q8. Evaluation of organization's protection level | No | No | Yes | 33% |

Figure 11. Healthcare experts' opinions on the use of the GhanaCard in Healthcare

From Figure 11, question 6 which is asking health experts' view on the potential benefits of implementing the GhanaCard as a tool in the healthcare sector, there was a 100% affirmative response. The table below (Table 8) shows the potential benefits as captured by the health experts:

| | |
|---|---|
| Health expert 1 | *"unfortunately, there's no system that has connected a patient history to the GhanaCard currently, because currently all those who patronize services with their GhanaCard, we can only access their NHIS status - be it expired, active, or inactive; based on that assessment, we can determine if we can enroll the patient using the NHIS, else the patient has to be enrolled as a private patient to be able to patronize service."* |
| Health expert 2 | *"...but I do think that, for instance, if you have certain records on your Ghana card that would be of significant importance in the case where you have an emergency and you are unable to communicate. So, for instance, with your GPS location, we'll be able to trace where someone lives from their GhanaCard and probably contact their family in the event of an emergency where a patient is brought in by a bystander... "* |
| Health expert 3 | *"I think if we bring in the GhanaCard to bridge this gap,... I think it's going to be a game changer for all of us; if someone attends this facility and the information is saved on a centralized system and can be accessed by using the GhanaCard and the consent of the patient. "* |

Table 8. Health experts' view on the benefits of implementing the GhanaCard as a tool

The question on whether the implementation of the GhanaCard in the healthcare sector could help reduce the burden of paperwork or address other challenges, one of the participant's responses is this: *"I think that with the right data protection rules that would make a difference with the proviso that, appropriate and stringent data protection rules are applied, yeah, it would make a difference."*, that goes to support Vroom's expectancy factor of motivation theory, which envisions that a cause will generate an outcome which is the effect. Responses by other experts are shown in Table 9:

As captured in Figure 11, a 100% score was recorded by all participants on the question of

| **Health expert 1** | **Health expert 3** |
|---|---|
| *"Yes! That would be very good and will lessen a lot of burdens because, in our day in day out practice, there are so many histories that are missed in the treatment of patients, to the extent that most of the time, a patient who has reached say stage four of the treatment protocols would patronize service at a different facility and we have to go and start all over again."* | *"You can just refer a patient without even a referral letter which is paperless; "* |

Table 9. Reduce the burden of paperwork or address other challenges

their health facilities' readiness to interconnect with other health facilities in the country. Table 10 captures some of the responses from the participants.

| | |
|---|---|
| Health expert 1 | *"Alright on the technical end, I'll say we are ready because if we were using the folder system, it would have been quite difficult, but currently, we have already enrolled into a fully paperless system which is fully electronic, so assessing any data on these GhanaCard and also having the interconnections with other facilities would be easier because we have already purchased the various materials or equipment that we need "* |
| Health expert 2 | *"Umm, I think that in the events that there was a strategy to rule out something of that nature, but the mechanisms for something like that to be rolled up already in place. I think our human resource component is well established, technology-wise, well established, internet bandwidth is reasonable, So yeah, I would say that we are quite ready."* |
| Health expert 3 | *"...but the thing is, every facility so far as they have the software system such as the Health Pro or the LHIMS or whichever software they are using to run the hospital so far as they have that means in the hospital, it concludes that every hospital can merge this thing. Certainly, it'll need human resources, technical resources, etc., and the hospitals have these resources already, so I think we are all ready for that. "* |

Table 10. Accessing the readiness of your organization

The question concerning the evaluation of health facilities' protection level posed to the health experts had a 33% score. This brings to play TAM's perceived usefulness and perceived ease of use of the system to be implemented, which are crucial factors determining the acceptance and intention to use this new technology. If healthcare experts or practitioners are not convinced that their organization's data protection level is adequate, they may perceive the system as not useful, which could reduce their intention to use it. However, with that said, all the experts had some optimism in their response to the question as captured in Table 11 below.

| | |
|---|---|
| Health expert 1 | *"Unfortunately, because medical issues here are not taken seriously, I still think that there's more work to be done because some people can access data whereby in the natural sense they shouldn't be able to unless they are permitted especially when they have the basic knowledge about how to access this data. So, I think that there's more to be done and that makes me think that we are not fully ready when it comes to data security; there's more that has to be done to ensure that at least only those who are expected to have access to a particular data have access."* |
| Health expert 2 | *"Yeah! So in that regard, if I compare the data protection regiments in Ghana, probably to that of the US; I would say that there's probably legislation but enforcement of the legislation, I would say would be a vulnerable point in implementing something like this, so I would say that regulation for data protection needs to be significantly optimized before we start providing accessibility via biometric means. Yeah, so I wouldn't be extremely confident in the current situation, especially comparing it to other places that I've seen."* |
| Health expert 3 | *"Our practice is patient confidentiality, so if I'm talking about protection, I have a password and a code that nobody has to assess the system for my patients – all doctors have their password and code as well. I can assess from my side what everyone has done, but I cannot edit what any other person has done apart from what I have done (LHIMS or Health Pro), so for that reason, I would say it's protected."* |

Table 11. Evaluation of organization's protection level

### 5.2.6 Healthcare Experts - Requirement and Support

| Requirement and Support | HC Expert 1 | HC Expert 2 | HC Expert 3 | Percentage |
|---|---|---|---|---|
| Q9. Collaboration of health facilities with NIA | Yes | Yes | Yes | 100% |
| Q10. Support from NIA & other public authorities | No | Yes | Yes | 67% |
| Q11. Challenges to be addressed | Yes | Yes | Yes | 100% |

Figure 12. Requirement and support from authorities

Takeaway from Vroom's expectancy theory suggests that an individual's motivation to use new technology is based on their expectations of the outcomes of some actions or their actions. From Figure 12, 100% positive collaborative ideas were put up by all participants. Table 12 depicts health experts' concerns and suggestions to have good outcomes. For this outcome to be made a reality, one of the experts suggests a broad stakeholder meeting to avoid past mistakes seen in the country:

The question about the support health facilities would require from the NIA or other public authorities, there was a total score of 67% (Figure 12), one comment saying that the

| | |
|---|---|
| Health expert 1 | *"So healthcare facilities should first and foremost work on migrating from a folder system to a paperless system that is the first and important step; after doing that, there's the need to look at the legalities of data security; we should be able to agree on the NIA access so that we'll be able to reform the data and interconnect them;"* |
| Health expert 2 | *"Yeah. I think for something of this nature, the first thing is always a very broad stakeholder consultation. That's something that has not been done previously and has impacted the rolling out of several policies that may have well had good intentions, but without the requisite stakeholder consultation and engagement, implementation becomes checkered. So, my first point of call would be broad stakeholder consultations, pitch the idea, get inputs, optimize the idea, pilot it, see success, and then probably restart rolling it out; so that that would be what I would recommend."* |
| Health expert 3 | *"I think this is a simple thing, it doesn't call for any absurd cost because already there has been a merger of the GhanaCard to SSNIT, NHIS, and others. There should be a stakeholder meeting to have a clear discussion about this involving the Ministry of Health (MoH) and the Ghana Health Service (GHS) and other institutions of health like the Ghana Medical and Dental Council which has a lot of expertise, as well as lawyers because we mentioned this confidentiality issues "* |

Table 12. Support from NIA and other public authorities

government together with the NIA should assist health facilities that are still running the paper-based management system within their facilities to quickly migrate to the paperless. Another also commented by saying that the support will come after a broad stakeholder meeting had to know the advantages and disadvantages; should the disadvantages surpass the advantages, then it will be a good thing because they could disagree to agree on the best options to take on the disadvantages.

However, the question on the likely challenges (including technical, ethical, and legal) that must be addressed to ensure successful use of the GhanaCard for healthcare services when implemented from healthcare experts provider's perspective, the score was a 100% with the following remarks. Expert 1 touched on the technical aspect by saying, *"First of all, technically, all health service providers must have already enrolled on a fully paperless system that is first, and secondly, the GhanaCard must be accepted by all"*. He touched on TAM's perceived usefulness and acceptance of new technology by all healthcare facilities [54]. Expert 1 went further to comment on the ethical aspect by saying: *"Also ethically, if somebody is denied the GhanaCard, that person is denied the basic necessity of a life of access to healthcare, it also corrects the legal issue. So I think that, apart from the healthcare providers moving on to an electronic system, the access to the GhanaCard must*

*be so easy to get even the newborns in the societies with assess to healthcare;".*

Expert 2 also commented on the ethical aspect by saying: *"So ethically, the main thing is the protection of patient data. Ethically and legally would be patients willing to have their data shared on any such platform? So, these are the things that the tenants of medicine would ensure are in position before anything of the sort could even be a probability or possibility. Technically, there would be a need for significant IT support."* Instrumentality, one of Vroom's key factors of motivation refers to a citizen's belief that improved performance will lead to desirable outcomes, in this case, the patient's will or being comfortable to have their data shared for them to have access to healthcare no matter where they find themselves is key. And finally, healthcare expert 3 had this to say: *"I think I've mentioned confidentiality already and it will be very disappointing that because there is a merger in this major development, then a confidentiality issue will be coming out all over the place and it would be very disappointing."*

From Figure 12, the question on challenges users (citizens or patients) are likely to face was posed and a 100% score response was received from all health experts. Two of the experts were concerned with users' easy accessibility to acquiring the GhanaCard. All institutions fully migrate to a paperless system, and prompt training on the new system. One of the experts also raised a concern about confidentiality, *"Well, I don't think the patient should even have a challenge, but you know, as I was saying, people have conditions, they are truly hiding, however, if the patient's confidentiality is assured that whatever I'm seeing you for won't get out there or won't be published, then the patient will be confident."*

### 5.2.7 Technical Experts - Pre-conditions

| Pre-conditions | Tech Expert 1 | Tech Expert 2 | Tech Expert 3 | Percentage |
|---|---|---|---|---|
| Q3. Technological infrastructure needed to support | Yes | Yes | Yes | 100% |
| Q4. Pre-conditions needed for biometric based authentication | Yes | Yes | Yes | 100% |
| Q5. Easiest option for the implementation of the GhanaCard | Yes | Yes | Yes | 100% |
| Q6. Collaboration of health facilities with NIA | Yes | Yes | Yes | 100% |

Figure 13. Technical experts - pre-conditions

On the question of what technology infrastructure is needed to support the implementation of the use of GhanaCard as a tool to bridge healthcare, a 100% score was recorded for all technical experts. Tech expert 1 had this to say: *"the technological infrastructure that would be needed to support the use of the GhanaCard in the healthcare services, you will need a healthcare management application that will be used to interact with the NIA API endpoint to allow you access to basic data of patients. Also, you will need a server to host the application as well as the patient data after performing KYC with NIA, and the last*

| | Tech expert 1 | Tech expert 2 | Tech expert 3 |
|---|---|---|---|
| **Positions** | ■ Software developer<br>■ Hardware troubleshooter<br>■ Server administrator<br>■ Database administrator<br>■ System's analyst administrator | ■ Technical support officer | ■ Technical support officer |
| **Duration** | 4 years | 5 years | 6 years |
| **Duties** | ■ Resolving NIA software issues<br>■ Troubleshooting NIA hardware components<br>■ Managing and maintaining NIA servers and internal applications<br>■ Ad-hoc duties | ■ Resolving technical issues nationwide<br>■ Resolution officers for user agencies (card verification) | ■ Troubleshoot network connectivity issues<br>■ First-level officer for card verification issues<br>■ Support personnel for mobile registration workstation (MRW)<br>■ Trainer for new joiners on MRW |

Table 13. Credentials of the various technical experts

*thing you'll need is a VPN which will allow you access to the NIA API."*. Tech expert 2 also had this to say: *"I think, there should be a credible common platform for all health institutions in the country and an API to interface this platform and the database of NIA"*. And finally, tech expert 3 had this to say: *"About the GhanaCard being used in health services, in my opinion, there will be a need for an API to interact with an NIA to access basic data of the patients such as name, location, height, other biodata, etc. Another thing would be the need for a server to host the application as well as the patient's data, which is the basic data they'll need to work with. Furthermore, a VPN would be needed for security reasons to access the NIA to facilitate safe data exchange. Finally, a database is needed to collect, store and access patient data."*

The three tech experts discussed the need for technological infrastructure to support the use of the GhanaCard in healthcare services. This includes a healthcare management application that would be used to interact with the NIA API endpoint, a server to host the application and patient data, a VPN for security, and a database to collect, store, and access patient data. This is an example of the Technology Acceptance Model (TAM) [54], which is a model used to understand the way users interact with technology. This model helps to

identify factors that influence user acceptance, enabling tech experts to better understand user behavior and preferences when using technology.

Question 4 from Figure 13, which is, what pre-conditions need to be fulfilled from NIA's perspective to enable the digital (including biometric) authentication of users in the healthcare sector of Ghana? All tech experts responded with 100% positive feedback. Table 14 gives a snapshot of the responses:

| | |
|---|---|
| Tech expert 1 | *"So NIA will have to provide an API endpoint that will allow the healthcare facilities to be able to access the basic data of patients with digital (including biometric) verification. Also, the NIA will be providing the VPN connection to the API for communication."* |
| Tech expert 2 | *"I think training and awareness on the importance of the use of the Ghana card in the health sector, because, it's a bit technical in terms of verification"* |
| Tech expert 3 | *"So I think there must be a legal agreement between the two institutions, you know you can't just get up and go to one institution and demand an integration of their system with yours. Also, NIA has to provide an API endpoint to access the basic data of patients with digital (including biometric) verification. The GhanaCard that NIA produces must be readable enough during verification, therefore NIA must produce quality cards. So basically, the legal agreement is the most important thing, then the API because that's what they are going to use (they can't have access to the whole NIA database); NIA has to produce the API; it is the duty of the NIA to produce the API and not the health sector."* |

Table 14. Pre-conditions needed for digital-based authentication

The three tech experts agree that for a successful integration of the NIA and the healthcare facilities, a legal agreement between the two institutions is necessary, GhanaCard produced by the NIA must be of high quality to be readable during verification, and the NIA must provide an API endpoint to access the basic data of patients with digital (including biometric) verification. These points are supported by the contract theory, which states that two parties must agree to and abide by certain terms for a contract to be valid [78]. The contract theory supports the need for a legal agreement between the two institutions mentioned by Tech Expert 3. The legal agreement will establish the terms and conditions for the integration of the NIA database with the healthcare system, including the scope of the API, data privacy, and security measures. The agreement will ensure that both parties understand their responsibilities and obligations, which is critical for the success of the integration. Furthermore, the agreement will provide a legal framework for resolving any disputes that may arise during the implementation of the integration.

Question 5 from Figure 13, getting the opinion of the tech experts on what the easiest option

for the implementation of the GhanaCard would be. Again there was 100% feedback. The three tech experts all suggest using a centralized health datastore, integration or synchronization with National Health Insurance Scheme (NHIS) and other private health insurance schemes, a common health management system, and an NIA API to keep track of patient's health records. This is supported by the Systems Theory which states that a system is composed of multiple parts that interact with each other to form a whole [79]. In this case, the different components of the system interact to store and keep track of patient's health records.

Question 6 from Figure 13, in which way can NIA work with healthcare providers to increase the interoperability of electronic health records? Yet again, there was a 100% feedback from all tech experts captured in Table 15:

| | |
|---|---|
| Tech expert 1 | *"OK, so from NIA's perspective, NIA can make available a publicly accessible secured API that healthcare service providers can communicate to retrieve patient data using any of the preferred verification methods, that is, either the person's biometrics, the ID card verification, or scanning."* |
| Tech expert 2 | *"First of all, training will have to be offered to all users of the system, then technical support for health workers and stakeholders would also have to be made available, then the API will also have to be accessible to healthcare agencies."* |
| Tech expert 3 | *"The NIA can only provide API because, at any point in time, the health facilities are looking forward to verifying the patient or getting basic data from the NIA API."* |

Table 15. Collaboration of health facilities with NIA

The three tech experts discussed the use of a publicly accessible secured API that healthcare service providers can use to communicate to retrieve patient data using any of the preferred verification methods. They agreed that training and technical support must be provided to all users of the system and that the API must be accessible to healthcare agencies.

| Protection | Tech Expert 1 | Tech Expert 2 | Tech Expert 3 | Percentage |
|---|---|---|---|---|
| Q7. Data protection measures applicable to the GhanaCard | Yes | Yes | Yes | 100% |
| 7a. Are the data protection measures sufficient? | No | Yes | Yes | 67% |
| Q8. Assurance of user privacy and confidentiality | Yes | Yes | Yes | 100% |
| Q9. Challenges to be addressed | Yes | Yes | Yes | 100% |
| Q10. Challenges users are likely to face | Yes | Yes | Yes | 100% |

Figure 14. Protection and assurance

Questions 7 and 7a from Figure 14, the question about the current protective measures applicable to the GhanaCard, all the tech experts gave 100% feedback with positive

information on Q7 but 67% on 7a. The three tech experts discussed the data protection measures applicable to the GhanaCard. Tech Expert 1 mentioned that data transmission is encrypted, and strong identity verification is required before data transfer channels are established. Data on the cards is also encrypted during transmission or verification. Tech Expert 2 added that there are various levels of encryption, including PKI, a dedicated VPN, and a three-tier database system. Tech Expert 3 emphasized that encryption is a fundamental component of data protection and that information on the GhanaCard is encrypted to prevent unauthorized access. The transmission medium is also encrypted, making it difficult for intruders to access the data.

However, when asked about finding them sufficient in the case of implementing the GhanaCard in the healthcare sector, this is what they had to say: The three tech experts discussed the sufficiency of data protection measures applicable to the GhanaCard in the healthcare sector. Tech Expert 1 mentioned that the data protection measures include encrypted data transmission and verification, and strong identity verification. Tech Expert 2 stated that the measures are sufficient and have been extensively tested. Tech Expert 3 added that the NIA has backup and recovery measures in place to prevent data inaccessibility during disasters.

Question 8 from Figure 14, how would the digital (including biometric) data stored on the GhanaCard be used to ensure user privacy and confidentiality from NIA's perspective? The three tech experts discussed how the digital (including biometric) data stored on the GhanaCard would be used to ensure user privacy and confidentiality from the perspective of the National Identification Authority (NIA). Tech Expert 1 stated that the private data stored on the GhanaCard is encrypted and not accessible without a connection through the NIA API. Tech Expert 2 added that access to the data can only be granted to people with the necessary clearance or privileges, and the devices used would have to be whitelisted. Tech Expert 3 emphasized that the encryption algorithm used by the NIA is of a high standard and offers high-level security. Even if data is breached, the data would not be retrievable by intruders.

Question 9 from Figure 14, asks about the challenges that must be addressed to ensure the successful use of the GhanaCard for healthcare services when implemented from NIA's perspective. All the tech experts gave 100% positive feedback. Tech Expert 1 emphasizes the need for compliance with data protection regulations and privacy policies by healthcare providers to protect patient data accessed from NIA. Tech Expert 2 highlights the need to limit access to digital data on a need-to-know basis, by the law, and to avoid the use of personal devices. Tech Expert 3 sees the inaccessibility of data from the NIA which could be a course of interference from the network and also recommends regular updates to

ensure the accuracy of personal data, such as change of home address, including height, etc, to be maintained at all times. Overall, the experts identified challenges such as compliance with data protection regulations, limiting access to digital (including biometric) data, and ensuring the accuracy of personal data, which are technical, ethical, and legal, that must be addressed to ensure the successful implementation of the GhanaCard for healthcare services from NIA's perspective.

Question 10 from Figure 14, poses the question, what challenges are users like to face? Feedback from all tech experts was a 100% score. The three tech experts discussed the possible challenges users may face when using the GhanaCard to access healthcare facilities. Tech Expert 1 mentioned the need for users to keep their GhanaCard updated and readable at the point of data access. Tech Expert 2 identified potential challenges such as the card being invalid if it hasn't gone through proper issuance processes, lack of approved verification devices or platforms, and lack of understanding of the system by healthcare providers. Tech Expert 3 highlighted the challenge of the GhanaCard being damaged and unable to be read for authentication when physical verification is required.

At the end of the discussion, only tech expert 2 had a few words to share. He concludes by pointing out the lack of a visible IT security/Cybersecurity unit at NIA, which is a problem that needs to be addressed to ensure that international standards and best practices are met for cybersecurity policies.

# 6. Discussion and Recommendation

This chapter deals with the final phase of the research and how the qualitative data presented in the research result helps answer the main research question *"How can the digital data of the GhanaCard be used in favor of the Ghanaian healthcare sector?"*. Aside from the main research question, there are sub-questions developed to have extensive results for the research. To conclude, this section will also present the researcher's limitations from the theoretical and interview standpoints.

## 6.1 Findings

To begin, the first sub-question is *"What are the technical requirements for implementing digital credentials in healthcare delivery in Ghana?"* The results showed that the three tech experts agree that there are certain technical requirements for implementing digital (including biometric) credentials in healthcare delivery in Ghana. Specifically, they discuss the need for a healthcare management application that would interact with the NIA's API endpoint, a server to host the application and patient data after performing KYC with NIA, a VPN for secure communication, and a database to collect, and store, and access patient data. They further agreed that these technical requirements are critical for the successful integration of the NIA database with the healthcare systems. Also, the results should that constant training for users and employees would be required due to the technicalities and update in verification processes.

Also, based on the opinions of the healthcare experts in Ghana, they seem to agree that the technical requirements for implementing digital credentials in healthcare delivery are mostly met. The health experts mentioned that the majority of healthcare facilities have already transitioned to electronic systems, which would make it easier to access data on the GhanaCards and connect with other facilities; with this said, TAM's perceived usefulness and perceived ease of use of the system will easily be attained. However, some health experts also expressed concerns about data security and suggested that more work needs to be done to ensure that only authorized personnel have access to patient data.

Furthermore, the second sub-question of the main research question, *"What are the legal and ethical considerations for introducing digital credentials in healthcare delivery in Ghana?"* The results showed that the tech experts suggest that a legal agreement is necessary to establish the terms and conditions for the integration of the NIA database

with the healthcare system, including the scope of the API, data privacy, and security measures. This agreement will ensure that both parties understand their responsibilities and obligations, which is critical for the success of the integration. Furthermore, the agreement will provide a legal framework for resolving any disputes that may arise during the implementation of the integration.

Additionally, the result showed that NIA's use of encrypted data transmission, strong identity verification, and backup and recovery measures ensures the security and availability of personal data. Furthermore, tech experts stated that the measures have been extensively tested, ensuring their effectiveness in preventing unauthorized access and protecting personal data. These measures are essential in the healthcare sector, where personal data is sensitive and subject to stringent data protection regulations hence these ethical considerations have been put in place.

Thirdly, the final sub-question of the main research question, *"What challenges and opportunities exist to facilitate the introduction of digital credentials in healthcare delivery in Ghana?"* The results showed that the foreseeable ethical and legal challenges such as when somebody is denied the GhanaCard, that person is denied the basic necessity of life and access to healthcare. On the technical aspect, if a health facility fails to integrate, the possibility of giving delayed or blindly administering care would be high.

Additionally, the health experts emphasized the importance or opportunity of collaboration and stakeholder meetings to ensure that everyone is on board with the implementation of digital (including biometric) credentials in Ghanaian healthcare. They also mentioned the need for better regulations and enforcement of data protection laws in Ghana. Overall, the experts seemed optimistic about the implementation of digital (including biometric) credentials in healthcare, although there is still work to be done to ensure its success.

Another opportunity raised by the technical experts from their comments is that it can be concluded that the NIA uses strong encryption to protect the digital (including biometric) data stored on the GhanaCard, ensuring user privacy and confidentiality. Also, access to the data is restricted to authorized users with clearance or privileges, and the devices used to access the data are whitelisted. The encryption algorithm used by the NIA is of a high standard, making it difficult for intruders to access the data even if there is a breach. These measures are essential in protecting personal data and ensuring compliance with data protection regulations.

Finally, the last research question, *"How can citizen involvement in an interoperable healthcare system with the GhanaCard be achieved?"* The results show that citizens have

had extensive application and use of the GhanaCard including medical services. They confirmed that the health facility they have attended for care uses a healthcare management system. Furthermore, they confirmed they have had no challenges with the operation of the healthcare management system. The citizens (patients) also believe and trust their respective healthcare providers to protect their medical records based on their reputation and length of relationship with them. In addition to that, there is a potential vulnerability in the OPD with a paper-based system.

The findings also suggest that citizens are comfortable and willing to use their GhanaCard to access their medical records regardless of the health facility they attend for care; because during emergency situations, care can be administered promptly. The findings also show that the convenience of not having to wait in long queues or fill out forms for a folder in health facilities will make them use their GhanaCard. Overall, the respondents believe that using the GhanaCard for healthcare services will simplify the process and make it more efficient.

The participants in the study expressed their agreement and comfort in using their GhanaCard as a means to access their medical records and receive better healthcare services. They mentioned the benefits of having their medical records easily accessible to any healthcare facility they visit and avoiding the need to carry physical files. They also emphasized the importance of using the GhanaCard for authentication to prevent identity theft and ensure the security of their personal information. Overall, they believe that using the GhanaCard to link and access medical records will improve the healthcare system in the country.

## 6.2 Recommendation

The following recommendations are made based on the findings of the study.

1. Stakeholder meetings: Representatives from private-public health facilities, and pharmaceutical companies or vendors should all come together for the initial and continuous brainstorming to help ensure all demerits or disadvantages that may arise are discussed to bring improvements.
2. Integration of healthcare systems: The study highlighted the need for the integration of healthcare systems in Ghana to allow for seamless access to medical records across different facilities and locations. It is recommended that efforts be made to integrate healthcare systems in Ghana to improve overall healthcare delivery and patient outcomes.
3. Improve data protection: Some participants expressed concerns about the security of their personal and medical information. To address this, it is recommended that there

be increased efforts to improve data protection measures and policies in healthcare facilities and systems.

4. Pilot programs: Given that the use of GhanaCard for healthcare access is still relatively new, it is recommended that pilot programs be established to test and evaluate the effectiveness and feasibility of using the GhanaCard for healthcare access. This will allow for any challenges to be identified and addressed before full-scale implementation.
5. Increase public education and awareness: The study revealed that many participants were not aware of the GhanaCard's potential for healthcare access. Therefore, it is recommended that there be increased public education and awareness campaigns to inform Ghanaians about the benefits and potential of the GhanaCard for accessing healthcare.

# 7. Limitations and Future Work

The present study centers on a case study of Ghana, a developing nation, which suggests a limitation to the generalizability and validity of the findings. It is crucial to note that utilizing the same model in other contexts may lead to divergent outcomes.

## 7.1 Limitations of the study

The first challenge of this methodology was convincing the focus group from the NIA that the study is solely for research purposes; privacy and security were often raised as a problem. The second challenge was getting health professionals (doctors) away from their busy schedules was overwhelming.

Secondly, the theoretical framework of the Technology Acceptance Model (TAM) has not been used in the healthcare sector to study why the healthcare industry, providers, infrastructure, and departments within health facilities are in silos, hence the generalization and validity pose a limitation. Should all the aspects of TAM be used in different cases, it is possible to expect similar or different outcomes from the study.

Thirdly, biometric systems, credentials, and cards are in their early stages in the healthcare industry, hence the application of Vroom's theory of motivation as well as the Biometric Technology Acceptance Model (BioTAM) has not been widely researched.

Finally, the researcher was only able to get interview responses of participants from three technical experts from the NIA *(issue of confidentiality and need-to-know-basis information which also limited the number of respondents)*, three healthcare experts (government health facilities), and only three citizens (patients) in a country with over 16 million registered GhanaCard holders.

## 7.2 Suggestions for Future Work or Research

This research was intended to learn how the digital (including biometric) data of the GhanaCard will be used in favor of the Ghanaian healthcare sector. Future research should look at the design phase of the to-be system and also focus on TAM's theory on Attitude, Usage, Support, and continuous Accessibility rate. It would also be interesting to look out for other variables such as Privacy and Security, Performance, and Risk.

# 8. Summary

In answering the main research question of how the digital (including biometric) data of the GhanaCard will be used in favor of the Ghanaian healthcare sector, this thesis evaluated the acceptance of the GhanaCard from theoretical, technical experts, healthcare experts, and citizens' perspectives.

The researcher adopted the Framework for Accessing e-Health Preparedness Theory, Vroom's Expectancy Theory, and (Biometric) Technology Acceptance Model to understand how the digital (including biometric) data of the GhanaCard can/will be used in favor of the Ghanaian healthcare sector. This led to the secondary data of some existing resources and primary data collection of 9 interviews from technical experts from the National Identification Authority, Healthcare experts, and citizens, and tested using the theories mentioned. The qualitative method also made it possible to gather more information from medical, and grey sources. The researcher transcribed the interview recordings from all three groups and coded them using MAXQDA Analytics Pro into themes. The themes were then used as sources for the direction the research went through. To broaden the scope of the data, the researcher showed some related work on e-Health preparedness from China and Iran's viewpoint. These works showed that no country or healthcare facility is truly ready, but with an understanding of previous mistakes, one is able to go through the hurdles of implementing new technology. Through the knowledge of the Framework of accessing e-Health Preparedness and Vroom's expectancy theory of motivation, the researcher was able to demonstrate that, healthcare facilities and citizens (patients) are mostly ready and willing to adopt the GhanaCard into the healthcare sector.

Although experts have given their inputs and assurances, a study conducted in China which was based on the theory of "Framework for Accessing e-Health Preparedness, one of the main challenges which were identified was the lack of standardization and integration of health facilities, hence optimum care and lessons should be taken. Another study conducted in Iran based on the same theory showed that areas in the country were low on preparedness where technical infrastructure, legal and ethical issues, and financial resources. As earlier discussed, a broad stakeholder meeting with policymakers and healthcare institutions need to identify the areas that would require immediate improvement for the successful implementation of the biometric system in Ghana.

The results affirm that the digital (including biometric) data of the GhanaCard is the way

forward for Ghanaians to have an interoperable healthcare sector. The future looking or high optimism of healthcare practitioners and citizens gives the assurance of perceived ease of use, hence a successful implementation after the broad stakeholder discussion (bringing out the advantages and disadvantages). The findings reveal that implementing the GhanaCard in the healthcare sector is the way forward in breaking down the siloed nature of the now-existing health system in Ghana.

# References


[1] Vera Ehrenstein et al. “Obtaining data from electronic health records”. In: *Tools and technologies for registry interoperability, registries for evaluating patient outcomes: A user’s guide, 3rd edition, Addendum 2 [Internet]*. Agency for Healthcare Research and Quality (US), 2019.

[2] Archana Tapuria et al. “Impact of patient access to their electronic health record: systematic review”. In: *Informatics for Health and Social Care* 46.2 (2021), pp. 194–206.

[3] Li Wang et al. “Identification of a new adtrp1-tfpi regulatory axis for the specification of primitive myelopoiesis and definitive hematopoiesis”. In: *The FASEB Journal* 32.1 (2018), p. 183.

[4] Doris Dokua Sasu. *Topic: Health system in Ghana*. Statista, Feb. 2022. URL: https://www.statista.com/topics/8915/health-system-in-ghana/#topicOverview.

[5] Blanca Escribano-Ferrer et al. “Quality of health care in Ghana: mapping of interventions and the way forward”. In: *Ghana medical journal* 50.4 (2016), pp. 238–247.

[6] Identification for Development (ID4D) World Bank Public Disclosure Authorized Public Disclosure Authorized Public Disclosure Authorized Public Disclosure Authorized. *The Role of Digital Identification for Healthcare: The Emerging Use Cases*. 2018. URL: https://documents1.worldbank.org/curated/en/595741519657604541/The-Role-of-Digital-Identificationfor-Healthcare-The-Emerging-Use-Cases.pdf.

[7] Jane Grimson. “Delivering the electronic healthcare record for the 21st century”. In: *International Journal of Medical Informatics* 64 (2001), pp. 111–127. DOI: 10.1016/s13865056(01)00205-2.

[8] Nilmini Wickramasinghe and et al. “A Framework For Assessing E-Health Preparedness”. In: (2004).

[9] Nilmini S Wickramasinghe et al. “A framework for assessing e-health preparedness”. In: *International journal of electronic healthcare* 1.3 (2005), pp. 316–334.

[10] Vincent Micheal Kiberu and et al. “Strengthening district-based health reporting through the district health management information software system: the Ugandan experience”. In: *BMC Medical Informatics and Decision Making* 14 (2014). DOI: 10.1186/1472-6947-14-40.

[11] Goverdhan Das Mogli. “Role of Biometrics in Healthcare Privacy and Security Management System”. In: *Sri Lanka Journal of Bio-Medical Informatics* 2 (2012), p. 156. DOI: 10.4038/sljbmi.v2i4.2245.

[12] Smith Oduro-Marfo, Teki Akuetteh Falconer, and Anri van der Spuy. “ Digital Identity in Ghana: Case study conducted as part of a ten-country exploration of socio-digital ID systems in parts of Africa”. In: (Nov. 2021). URL: https://researchictafrica.net/publication/digital-identity-in-ghana-case-study-conducted-as-part-of-a-ten-countryexploration-of-socio-digital-id-systems-in-parts-of-africa/.

[13] John Effah and Emmanuel Debrah. “Biometric technology for voter identification: The experience in Ghana”. In: *The Information Society* 34 (2018), pp. 104–113. DOI: 10.1080/01972243.2017.1414720.

[14] Dimitrios Katehakis and Angelina Kouroubali. “A Framework for eHealth Interoperability Management”. In: *Journal of Strategic Innovation and Sustainability* 14 (2019), p. 51.

[15] National Identification Authority. *Statistics*. May 2020. URL: https://nia.gov.gh/statistics/.

[16] Nicolas Kayser-Bril. “Identity-management and citizen scoring in Ghana, Rwanda, Tunisia, Uganda, Zimbabwe and China”. In: *Algorithm Watch, October* 22 (2019).

[17] “The GhanaCard Introduction”. In: (2020). URL: https://nia.gov.gh/the-ghanacard-introduction/.

[18] National Identification Authority. *FAQs*. National Identification Authority. URL: https://nia.gov.gh/faqs/ (visited on 01/13/2023).

[19] Ghana Business News. *President Launches New National Identification Card*. Sept. 2017. URL: https://www.ghanabusinessnews.com/2017/09/15/president-launches-new-national-identification-card/.

[20] John Effah and Emmanuel Owusu-Oware. “From national to sector level biometric systems: the case of Ghana”. In: *Information Technology for Development* 27.1 (2021), pp. 91–110.

[21] Wiafe Agyemang-Duah et al. “Biometric identification systems in healthcare delivery in Ghana: prospects and challenges”. In: *BMC research notes* 12.1 (2019), p. 585.

[22] B Kofi, P A Amoah, and E K Aggrey. *Biometric Authentication System for Healthcare Delivery in Ghana: A Case Study*. 2017.

[23] F Adomako, A E Yawson, and R Glover. “Biometric authentication in healthcare delivery: A case study of Ghana”. In: *Journal of Health Informatics in Developing Countries* 13.1 (2019).

[24] Eliezer Ofori Odei-Lartey et al. “The application of a biometric identification technique for linking community and hospital data in rural Ghana”. In: *Global health action* 9.1 (2016), p. 29854.

[25] B Kofi and E Oduro-Ofori. *Biometric identification for improving patient identification in Ghana: A review of the Ghana Card*. 2019.

[26] M.D. Adu and B. Kofi. “Implementation of a Biometric Authentication System for Health Care Delivery in Ghana”. In: *Journal of Information Technology and Software Engineering* 11.1 (2021), pp. 1–7.

[27] E.P. Mensah. “The potential of biometric data in healthcare delivery in Ghana”. In: *International Journal of Health Policy and Management* 10.11 (2021), pp. 665–668.

[28] Emmanuel K. Dzisi and Richard Boateng. “Biometric authentication for healthcare delivery in Ghana”. In: *Journal of Health Informatics in Africa* 5.1 (2018), pp. 30–41.

[29] Khaled Abu-Maala and Mohammed Al-Shamiri. “Biometric identification and medical identity theft in Ghana”. In: *Health Information Science and Systems* 9.1 (2021), pp. 1–11.

[30] C. P. Akuoko, E. Antwi, and E. K. Darteh. “Patients and healthcare providers’ perceptions of the use of biometric authentication for healthcare delivery in Ghana”. In: *BMC Medical Informatics and Decision Making* 19.1 (2019), p. 46.

[31] Jerry Fosu, Charles Opoku-Agyeman, and Ernest Adu-Gyamfi. “Biometric Data in Managing Chronic Diseases in Ghana: A Study of Its Impact on Patient Management”. In: *Journal of Health Informatics in Developing Countries* 13.1 (2019), pp. 22–31.

[32] Paul A Abor and Kwabena A Osei. “The impact of biometric technology on healthcare financing in Ghana”. In: *Journal of Health Informatics in Developing Countries* 8.2 (2014), pp. 14–24.

[33] David Blumenthal and Marilyn Tavenner. “The “meaningful use” regulation for electronic health records”. In: *New England Journal of Medicine* 363.6 (2010), pp. 501–504.

[34] NEJM Catalyst. *Healthcare Big Data and the Promise of Value-Based Care*. NEJM Catalyst, Jan. 2018. URL: https://catalyst.nejm.org/doi/full/10.1056/CAT.18.0290.

[35] Matthew Castellano and Steve Scibetta. “An automatic response: Looking to improve your revenue cycle? For UNC Hospitals, technology was key”. In: *Healthcare Financial Management* 59.9 (2005), pp. 90–93.

[36] Carol C Diamond, Farzad Mostashari, and Clay Shirky. “Collecting and sharing data for population health: a new paradigm”. In: *Health affairs* 28.2 (2009), pp. 454–466.

[37] Sara Rosenbaum. “The affordable care act and civil rights: The challenge of section 1557 of the affordable care act”. In: *The Milbank Quarterly* 94.3 (2016), p. 464.

[38] Theo Lippeveld et al. *Design and implementation of health information systems*. World Health Organization, 2000.

[39] Kathrin Cresswell, Robin Williams, Aziz Sheikh, et al. “Developing and applying a formative evaluation framework for health information technology implementations: qualitative investigation”. In: *Journal of medical Internet research* 22.6 (2020), e15068.

[40] Julia Adler-Milstein and Ashish K Jha. “HITECH Act drove large gains in hospital electronic health record adoption”. In: *Health affairs* 36.8 (2017), pp. 1416–1422.

[41] George Hripcsak et al. “Use of electronic clinical documentation: time spent and team interactions”. In: *Journal of the American Medical Informatics Association* 18.2 (2011), pp. 112–117.

[42] Alan J Forster et al. “The incidence and severity of adverse events affecting patients after discharge from the hospital”. In: *Annals of internal medicine* 138.3 (2003), pp. 161–167.

[43] S Trent Rosenbloom et al. *Interface terminologies: facilitating direct entry of clinical data into electronic health record systems*. 2006.

[44] D Tony Yu et al. “Electronic health record feedback to improve antibiotic prescribing for acute respiratory infections”. In: *Am J Manag Care* 16.12 (2010), e311–e319.

[45] Fred D Davis, Richard P Bagozzi, and Paul R Warshaw. “User acceptance of computer technology: A comparison of two theoretical models”. In: *Management science* 35.8 (1989), pp. 982–1003.

[46] Jessica S Ancker et al. *Effects of workload, work complexity, and repeated alerts on alert fatigue in a clinical decision support system*. 2017.

[47] Caroline Lubick Goldzweig et al. “Costs And Benefits Of Health Information Technology: New Trends From The Literature: Since 2005, patient-focused applications have proliferated, but data on their costs and benefits remain sparse.” In: *Health affairs* 28.Suppl2 (2009), w282–w293.

[48] Maria Alcocer Alkureishi et al. “Impact of electronic medical record use on the patient–doctor relationship and communication: a systematic review”. In: *Journal of general internal medicine* 31 (2016), pp. 548–560.

[49] Junhua Li et al. “e-Health preparedness assessment in the context of an influenza pandemic: a qualitative study in China”. In: *BMJ open* 3.3 (2013), e002293.

[50] M Rezai-Rad, R Vaezi, and F Nattagh. “E-health readiness assessment framework in Iran”. In: *Iranian journal of public health* 41.10 (2012), p. 43.

[51] Jacques Igalens and Patrice Roussel. “A study of the relationships between compensation package, work motivation and job satisfaction”. In: *Journal of organizational behavior* 20.7 (1999), pp. 1003–1025.

[52] Stefania De Simone. “Expectancy value theory: Motivating healthcare workers”. In: *American International Journal of Contemporary Research* 5.2 (2015), pp. 19–23.

[53] Nikola Marangunić and Andrina Granić. “Technology acceptance model: a literature review from 1986 to 2013”. In: *Universal access in the information society* 14 (2015), pp. 81–95.

[54] Bahlol Rahimi et al. “A systematic review of the technology acceptance model in health informatics”. In: *Applied clinical informatics* 9.03 (2018), pp. 604–634.

[55] Poey Chin Lai. *The literature review of technology adoption models and theories for the novelty technology*. 2017.

[56] Alper Kanak and Ibrahim Sogukpinar. “BioTAM: a technology acceptance model for biometric authentication systems”. In: *IET Biometrics* 6.6 (2017), pp. 457–467.

[57] Meennapa Rukhiran, Sethapong Wong-In, and Paniti Netinant. “User Acceptance Factors Related to Biometric Recognition Technologies of Examination Attendance in Higher Education: TAM Model”. In: *Sustainability* 15.4 (2023), p. 3092.

[58] Kashish A Shakil et al. *BAMHealthCloud: A biometric authentication and data management system for healthcare data in cloud*. 2020.

[59] Richard J Holden and Ben-Tzion Karsh. “The technology acceptance model: its past and its future in health care”. In: *Journal of biomedical informatics* 43.1 (2010), pp. 159–172.

[60] Marie Pierre Gagnon et al. “Using a modified technology acceptance model to evaluate healthcare professionals’ adoption of a new telemonitoring system”. In: *Telemedicine and e-Health* 18.1 (2012), pp. 54–59.

[61] Lazar Vuletic et al. “Are M-health Applications Accessible for Elders?” In: ().

[62] Alan Bryman. *Social research methods*. Oxford university press, 2016.

[63] Anni-Kaisa Kahkonen. “Conducting a case study in supply management”. In: *Operations and Supply Chain Management: An International Journal* 4.1 (2014), pp. 31–41.

[64] Carl McDaniel and Roger Gates. *Marketing research essentials*. Wiley Global Education, 2012.

[65] Louis Cohen, Lawrence Manion, and Keith Morrison. *Research methods in education*. routledge, 2017.

[66] Emma Bell, Alan Bryman, and Bill Harley. *Business research methods*. Oxford university press, 2022.

[67] Sara Paparini et al. “Case study research for better evaluations of complex interventions: rationale and challenges”. In: *BMC medicine* 18.1 (2020), pp. 1–6.

[68] John W Creswell and J David Creswell. *Research design: Qualitative, quantitative, and mixed methods approaches*. 2017.

[69] American Psychological Association et al. “Ethical Principles of Psychologists and Code of Conduct; American Psychological Association, 2017”. In: ().

[70] A Rubin and ER Babbie. *Qualitative research: General principles*. 2011.

[71] Roselind Lieb. “Population-Based Study”. In: *Encyclopedia of Behavioral Medicine*. Ed. by J. Rick Gellman Marc D.and Turner. New York, NY: Springer New York, 2013, pp. 1507–1508. ISBN: 978-1-4419-1005-9. DOI: 10.1007/978-1-4419-1005-9_45. URL: https://doi.org/10.1007/978-1-4419-1005-9_45.

[72] Melissa P Johnston. “Secondary data analysis: A method of which the time has come”. In: *Qualitative and quantitative methods in libraries* 3.3 (2014), pp. 619–626.

[73] Charles P Friedman, Jeremy Wyatt, and Joan S Ash. *Evaluation methods in biomedical and health informatics*. 2022.

[74] Floyd J Fowler Jr et al. “Coding cognitive interviews: an approach to enhancing the value of cognitive testing for survey question evaluation”. In: *Field Methods* 28.1 (2016), pp. 3–20.

[75] W Neuman Lawrence. “Social Research Methods: Qualitative and Quantitative Approaches. Pearson”. In: (2014).

[76] Laurence Bardin. “Content analysis”. In: *São Paulo: Edições* 70.279 (2011), pp. 978–8562938047.

[77] Gill Kirton and Anne-Marie Greene. *The dynamics of managing diversity and inclusion: A critical approach*. 2021.

[78] Alan Schwartz and Robert E Scott. “Contract theory and the limits of contract law”. In: *Yale LJ* 113 (2003), p. 541.

[79] Peter Larsson, Sidney WA Dekker, and Claes Tingvall. “The need for a systems theory approach to road safety”. In: *Safety science* 48.9 (2010), pp. 1167–1174.

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# Appendix 2 – Interview Questions

## Citizen or Patient

## Introduction

Q1. Gender of citizen or patient

a) Male

b) Female

Q2. Age range of citizen or patient

a) Below 20 b) 20-29 c) 30-39 d) 40-59 e) 50 and above

Q3. What is your personal or current experience with the GhanaCard?

3a. What services have you used the GhanaCard for?

3b. Are there any challenges you have been facing?

Q4. How often do you use healthcare services? *(Once a year, more than once a year, I do not remember when I last time used any healthcare services)*

## Questions

Q5. How does your current healthcare service provider identify and handle your health records?

5a. What kind of challenges have you faced?

Q6. Do you think that your healthcare service provider(s) have applied sufficient data protection measures to your data?

Q7. Would you be comfortable using your GhanaCard to access all healthcare services *(hospitals, clinics, pharmacies - public or private)* in Ghana if implemented?

7a. Yes, why?

7b. No, why?

Q8. What is your expectation towards using the GhanaCard in the healthcare sector?

Q9. Have you ever requested to have a view of your health records in any of the healthcare facilities you've visited in Ghana?

9a. What was your experience?

9b. Is it also possible you could see your records outside the health facility?

Q10. What potential benefit(s) do you foresee if the GhanaCard is used as a tool to bridge all healthcare facilities in Ghana (public or private)?

10a. Do you think that could improve the overall healthcare system in Ghana?

Q11.Do you think linking the GhanaCard to your health records would maintain patient-doctor confidentiality?

11a. If yes, why?

11b. If no, why?

Q12. Is there anything else you would like to add?

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## Technical Expert

## Introduction

Q1. Please tell me about your current position and describe your responsibilities.

Q2. How long have you been working in this sector and what is your involvement with the GhanaCard?

## Questions

Q3. What technological infrastructure is needed to support the use of the GhanaCard in healthcare services?

Q4. What other pre-conditions need to be fulfilled from NIA´s perspective to enable the biometric-based authentication of users in the healthcare sector of Ghana?

Q5. What would be in your opinion the easiest option for the implementation of the GhanaCard in the healthcare sector?

Q6. How can NIA work with healthcare providers to increase the interoperability of electronic health records?

Q7. Please describe the current data protection measures applicable to the GhanaCard.

7a. Do you find them sufficient in the case of implementing the GhanaCard in the healthcare sector?

Q8. How would the digital (including biometric) data stored on the GhanaCard be used to ensure user privacy and confidentiality from NIA's perspective?

Q9. What challenges (including technical, ethical, and legal challenges) must be addressed to ensure the successful use of the GhanaCard for healthcare services when implemented from NIA's perspective?

Q10. What challenges are users likely to face while using the GhanaCard to access healthcare facilities if implemented?

Q11. Is there anything else you would like to add?

## Healthcare Expert

## Introduction

Q1. Please tell me about your current position and describe your responsibilities.
Q2. How long have you been working in this field?
2a. What is your current experience with the GhanaCard?

## Questions

Q3. Please describe how the health care records management (including the access management) is organized in your organization.
Q4. How do you retrieve and authenticate the patients' healthcare records (NHIS card or folder) whenever a patient visits the facility?
Q5. How do you identify and document patient(s) visiting from other health facilities without being previously documented and with no healthcare history?
Q6. What potential benefits do you foresee in implementing the GhanaCard as a tool to bridge healthcare accessibility?
6a. Would you believe that would help reduce the burden of paperwork or address other challenges?
Q7. How would you assess your organization's readiness (technical, organizational, people) to implement the GhanaCard?
Q8. How would you evaluate your organization's data protection level and readiness to process digital (including biometric) data?
Q9. How can healthcare facilities in Ghana work with the NIA to increase the interoperability of electronic health records?
Q10. What kind of support do the healthcare service providers require from NIA or other public authorities to implement the GhanaCard?
Q11. What challenges (including technical, ethical, and legal challenges) must be addressed to ensure the successful use of the GhanaCard for healthcare services when implemented from a healthcare service provider´s perspective?
Q12. What challenges are users likely to face while using the GhanaCard to access healthcare facilities if implemented?
Q13. Is there anything else you would like to add?